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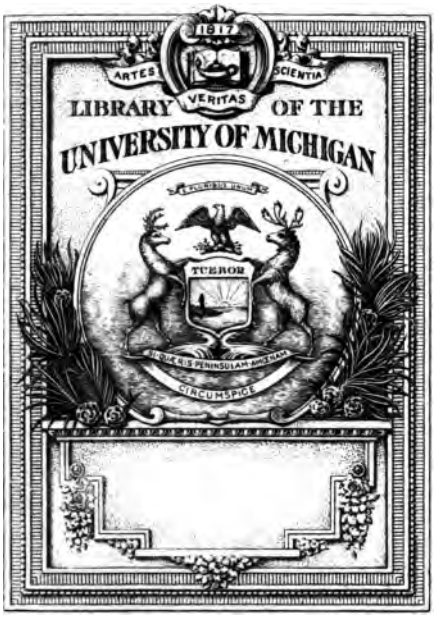

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PROCESS ENGRAVING

FORMULAS, EQUIPMENT, AND METHODS OF WORKING

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PROCESS ENGRAVING

FORMULAS, EQUIPMENT, AND METHODS OF WORKING

BY
EDWARD S. PILSWORTH

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PROCESS ENGRAVING

FORMULAS, EQUIPMENT, AND METHODS OF WORKING

PROCESS ENGRAVING

CHAPTER 1

INTRODUCTION

BEFORE the invention of movable types, which made printing, as we now understand it, possible, pages were cut and printed as a whole, and rough illustrations, or initial letters, or bits of ornament were cut with the type and all printed together. In this way the page was one complete integer; the illustrations were as much a part of the printed page as the letters were, and everything was combined into a harmonious, and, sometimes, very beautiful whole.

With the invention of movable types the illustrations, or decorations, were necessarily cut separately, but the early masters had precedent to follow, and their illustrations, while made up of finer lines, or more intricate shadings, were drawn and engraved so that they, also, were an integral part of the page. Then more ambitious attempts at illustration were made by Guilio Romano, Collot, Cruikshank, and others, beginning with copper etchings,

and finally culminating in the steel plates familiar to th Victorian era.

This work, however, while part of the book, was nc an integral part of the page. The process was of an en tirely different character, the illustrations being etche or cut on copper or steel, printed intaglio instead of fron the surface, possibly on a different grade or kind of paper and "tipped" into the book after the printing of the lat- ter was done and the signatures made up and bound. Being so different, they always looked, as indeed they were, something added from the outside, and so were not, by any means, satisfactory.

Wood cuts were also used, printed in the regular forms, and, as decorative illustrations were sometimes of sur- passing beauty and effectiveness. Hans Holbein and Al- brecht Dürer are particularly remembered for their won- derful work. Yet these illustrations were almost wholly decorative in conception and execution, for wood engrav- ing was not advanced enough to make possible the masses of varied tones or chiaroscuric shadows so necessary for naturalistic work. The white line in wood engraving was not invented, and, without it, absolutely finished engrav- ing of tones and shadows such as Timothy Cole did some few years ago, was impossible.

With the invention or discovery of the white line by Berwick, wood engraving took on a new lease of life, and many beautiful illustrations were made and some won- derful reproductive engravings were cut. There were

many drawbacks, however; the cost was great; the work of one man, the artist, must be interpreted by another, the wood engraver; and above all, it was a slow process of duplication and took much time. A large block, if intended for any early publication, must be divided into parts and these parts cut by different workmen, with the manifest disadvantage of a difference in individual technique; and, lastly, which added still further to the delay, each wood engraving had to be electrotyped before being printed. The heyday of the wood engraving was the latter part of the nineteenth century.

With the invention of photography by Daguerre, there began a strong effort to use the new discovery for the making of engravings, and it was not many years before line drawings were being etched upon zinc.

The reproduction of photographs, wash drawings, etc., or any copy in which the degrees of shadow were graded tints, and not graded lines was a different matter, and some time elapsed before the invention of the halftone by Meisenbach, and its final perfection by Ives made it possible to reproduce such "copy." The final success of both these processes, however, was thorough and complete, until, at the present time, practically every illustration that we see, is the result of one or other of these methods. Between them, they are capable of fulfilling every requirement of engraving; they will reproduce any style of drawing, whether in black or tones, decorative or naturalistic, contrast or chiaroscuro. The coarsest or the

daintiest technique can be reproduced with the least expenditure of time, and the cuts can be locked up in the chase with the type, printed in the same press at the same time, and are an integral part of the printed page.

The modern process engraving shop is an altogether different place to the one where wood engravings used to be made. In the latter, unless it was a large establishment, a few wood engravers, mixed with a few artists, cut away slowly on pieces of wood. In one corner was a ruling machine, and in another, or close to the sink, a place for photographic printing on wood. This was practically all the machinery, unless maybe a small proof press, so that the capital required was very little, and such a room was a type of what was more or less common all over the country. The work was slow, very expensive, not very satisfactory when done, and those employed in it not very numerous, most of the shops being one or two men affairs. The big majority of these men were absorbed into the new process engraving shops as finishers.

The process shop is on an altogether different basis. Leaving out the art room (which to some extent resembles the old-time wood studio), there is a much more numerous body of men, their occupations are more diverse, the work goes through much more quickly, and there are many more mechanical appliances than the old ruling machine, which is seldom used at all. The photographic room, with two or three large cameras, oftentimes

very many more, blazing arc lights, and the scent of chemicals, the etching room with rocking tubs, printing room with heavy, massive frames and electric arcs; the blocking rooms with saws spinning, routers whizzing, bevellers and other machines running at high speed; or the finishing room, with one or more large proof presses, present a vastly different picture.

The coöperation and interdependence of one department with another is also very different. In wood engraving, the engraver generally took the drawing on the wood and engraved it all himself (unless the shop was large enough to keep a special man for the ruling machine). In the process shop the drawing goes to the photographer who photographs it, the negative is then stripped, printed on metal, and etched; later, routed, or beveled, or blocked, and lastly, finished and proved. And yet, withal, this multiple handling is very efficient, and the work travels through at a rapid rate. It is possible (though not profitable), to put a cut through in an hour or even less, and by this speed has been built the newspaper illustrations that were practically impossible with wood cuts. Drawings or photographs are brought in, photographed, etched, proved, and delivered to customers in endless variety and beauty, and with a speed and precision that is little short of marvelous.

Many houses, particularly in the large centers, run two shifts, a night and day force, utilizing the expensive machinery continually, and thus lessening the cost of

rent, overhead, etc., while giving service that answers any or every requirement. An artist may finish a drawing at four o'clock one afternoon; and the cut from it will be ready for delivery before eight the next morning.

It will be seen that the capital required for the equipment of such a shop is considerable, running into thousands of dollars, according to the size of the plant required. Lenses, half-tone screens, arc lights, cameras, blocking and routing machinery are expensive articles, and the result is that where the wood engraving shop was run by the owner, who usually worked in it, photo engraving is a business, usually a stock company, and run as any other business is run. It is really on a factory basis, a basis of efficiency, where one man is not expected to complete the whole process himself, but where he has a certain part of it to do, and then passes it over to another workman, who passes it to another, and so on until the work is completed. In this way, one man photographs, one prints, another etches, routs, finishes, proves, etc. And, through long practice in their particular specialties, the skill of many of these workmen becomes very great, and the speed with which they handle the work remarkable.

For experimental purposes it is possible to do without most or nearly all of this expense, and one man can carry the work along alone; but it has been found, in actual business practice, that this is impossible, as one cannot compete in price or output with a well equipped

plant. Even with equipment it is doubtful if a shop with less than three workmen can be run at a profit, as they cannot do enough work to counteract the overhead expense, and compete with larger establishments.

The workmen engaged in process engraving have more than the average intelligence, a fact that in some ways accounts for the scale of wages in their craft, which is, by far, the highest in the allied printing trades.

CHAPTER 2

PHOTOGRAPHY

1. Photographic Equipment

THE tools and mechanical appliances used in the average engraving house are many, vary considerably in character, being electrical, chemical and purely mechanical, and some of them are quite expensive. It is quite possible, for experimental or other purposes to do without most of them, but they are great time and labor savers, and any one of them will earn their cost many times over in the course of a year. There are few shops so small that they do not have a fairly full line, for it has been proven good policy, and a saving of both time and money to invest in them. Up to, and including the etching, they are mostly distinctive, and are set apart as tools especially designed for the photo engraving business, or to fill some particular need thereof; but the blocking machinery is often a duplicate of that used in electrotype foundries, and can be used as readily for one as the other.

Beginning with the equipment used in photography, which is the starting point for all cuts, there are some

adapted or borrowed from chemistry, some electrical, and some peculiar to photography itself, and used in no other industry.

Photography

When process engraving was first practiced, most negatives were made by daylight, but for shops where a steady output was desired, or where a night force was "run" such a method of work was found to be impracticable. Cloudy days made it impossible to work at all, and so "copies" (as drawings or photographs from which etchings are to be made, are known), are now lighted artificially by arc lights. Some of these lights are very powerful, but the average is probably about 2000 candlepower.

The Arc Light. There are various makes of arc lamps for photographing purposes, but the one shown in Fig. 1 is a fair sample, though they come in varied detail, some, known as "double deckers," even have two lamps on one stand. They are always bought in pairs, one to stand on each side of the copy board, so as to give an even illumination, and, for the average copy, are set about twenty-four inches away. Level, even illumination is an absolute essential to good photographing, for it must never be forgotten that it is the light that is photographed, and if the copy is unevenly lighted, then one place will show brighter than another, and two tones of exactly the same depth on the copy will photograph very

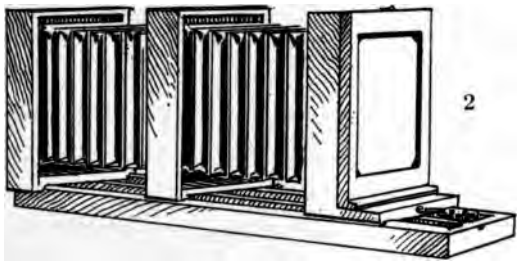
differently, if the lighting is not uniform. On large copies, the lights are sometimes pulled farther back, and with smaller copies pushed closer; the exposure, of course, varying accordingly.

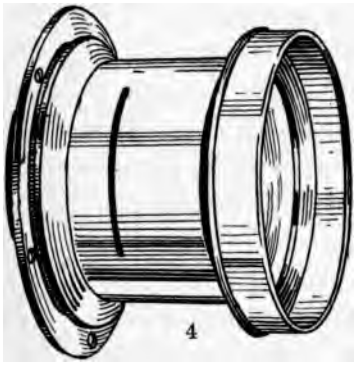
Photographing lamps have been brought to a high state of perfection, requiring very little care or attention outside of new carbons now and then, and a little oil occasionally, and some are even "corrected" for color work, or for special uses.

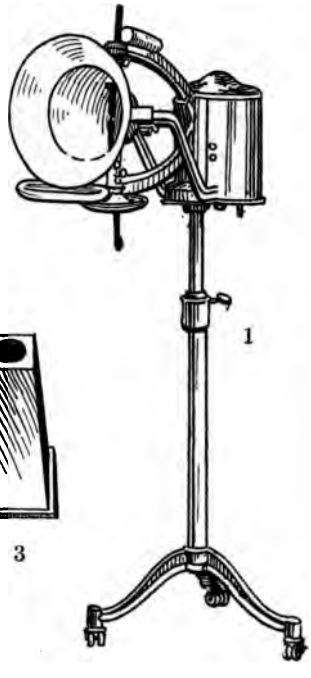
The same kind of lamps may also be used for printing on zinc or copper (though a special printing lamp is made), sometimes one, sometimes two being used, largely depending on the size of the printing frame, and sometimes in small shops these photographing lamps are swung around and used to save the expense of extra equipment.

The Camera. The camera used in process work is very different from those we are so familiar with in dry plate work. It is a large affair, the usual size being 11 x 14 inches, or 14 x 17 inches, and generally stands on a frame hung on springs, with the copy board fastened to one end of it, so that in case of a jar or any movement, the board and camera will move in unison. Fig. 2 shows a popular form of camera.

One requirement of an engraving camera is that it shall be capable of "large" reductions, and also enlargements when necessary. Much of this depends, of course, upon the lens, but the average camera, when fully set up,







PHOTOGRAPHIC EQUIPMENT

Fig. 1. Arc Lamp.—Fig. 2. Camera.—Fig. 3. Cone.—Fig. 4. Lens.—Fig. 5. Stop.

will enlarge two or three times, and reduce six or seven. The bellows must be easily worked, must move freely, and the camera must lock rigidly in position when the proper size and focus is obtained. The one shown in Fig. 2 has a double bellows, but many have three or even more, according to the length it pulls out. The object of the partitions between is to act as a support to the bellows, and prevent sagging, and also, in most cases, to make smaller reductions than would be possible without them. The smaller the reduction, the shorter the distance between the lens and the plate must be, and if there is a partition in the center in which the lens may be fastened, it necessarily reduces the distance one-half, thus enabling the operator to reduce a copy to a much smaller size.

If the reduction of the distance between the lens and plate will make a smaller image possible, it naturally follows that increasing the length between these two surfaces will make a larger image, and if this distance can be increased even beyond the stretch of the bellows, it will give an image greater in size than the camera alone will be capable of. To do this, a "cone" is used, shown in Fig. 3. It is made of wood, with a round hole in the small end, into which the flange of the lens can be screwed, and with projecting edges at the large end to fit into the place on the front board in the face of the camera.

The front board of a camera is a board into which the

lens is fitted, and is removable. It generally works vertically in a flange and in most modern cameras horizontally as well, enabling the operator to bring the image of the copy upon the exact center of the plate.

The end of the camera that is shown is the one where the ground glass is, which is simply a sheet of ground glass mounted in a removable frame, at the exact distance from the lens that the sensitive plate will be when exposed. It is used for focussing upon, and is held in place by a catch at the top; the corners of the glass are also cut out to allow air to escape when the bellows of the camera are closed, or to allow air to enter when they are lengthened.

The front of the camera is usually stationary, the difference in the length of the bellows being obtained by pushing the back forward, or pulling it out, and this is done by sliding the wooden partition back and forth upon tracks to which they are fitted, there being usually three, one on each side, and one in the center. The device for holding the back rigid when proper distance is obtained, generally works upon the center track, and may consist of a screw or an eccentric, or, in fact, anything that will hold the back solid.

The Lens. One of the most important tools of the photographer is the lens. There are many reliable instruments to be bought, varying somewhat in style and price, but all equally good for the average run of work. The principal requirements of a process lens are, that it

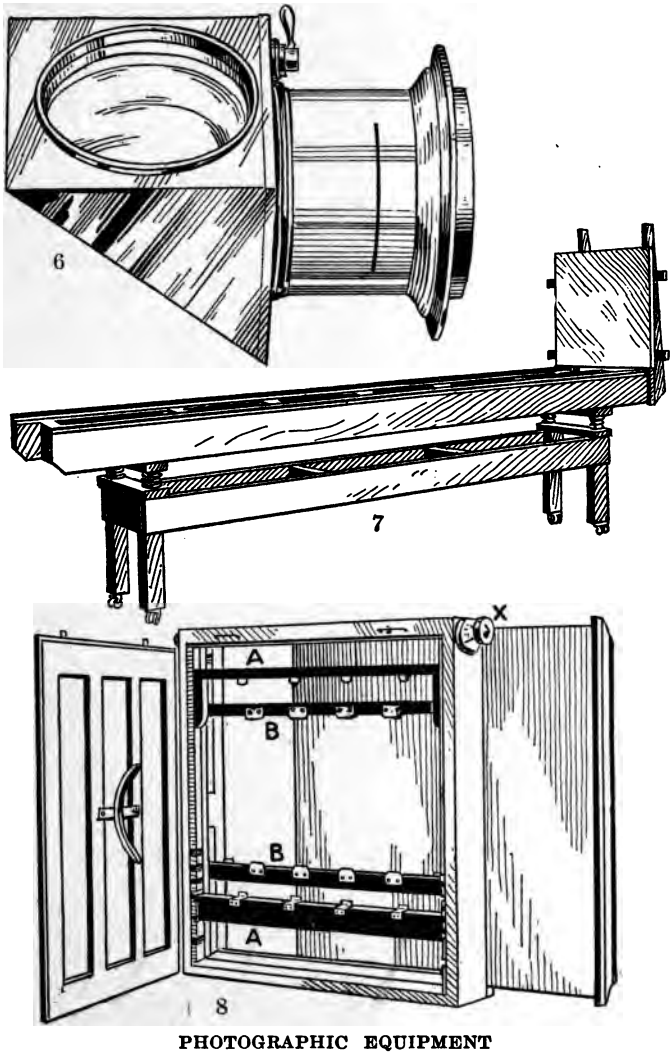
shall be reasonably speedy, give a flat, even image, have absolutely no distortion, work with an even speed all over the plate, and cut sharp to the corners. It is always the safest plan to use a lens that is somewhat larger in size than the camera on which it is to be used, because a smaller lens, or even one that is supposed to have the capacity of the camera may not reach to the extreme corners in a manner to satisfy the operator. It should cover the full size "wide open," then there can be no doubt of its capacity when "stopped down," which means used with a small stop.

Fig. 4 shows a common type of lens, the slot showing in the barrel being the place where the stops are dropped in. There are several devices for doing away with the necessity of taking out stops to change them, some of which work very well, but the majority of photographers prefer to use the old Waterhouse stops, and to change them by means of the slot in the barrel of the lens.

Stops. Fig. 5 shows a Waterhouse stop with a square hole. They are usually made of brass, thin enough to handle easily, but heavy enough so that they will not buckle or bend. Stops are used for both line and half tone negatives. An open lens will not cover nearly so large a plate as sharply, as will one with a diaphram in it; the smaller the stop, the larger the plate may be, and the sharper the lens will cover the outside corners. It is on the corners that any diffusion of focus will occur, because of the fact that the lens throws in a circle, and

the sides of the plate may be well within its focal power, while the corners may be outside of it. There are, of course, limits to the size of stop an operator may use, for, while a small size may cut a large plate more sharply at the edges than a larger sized stop, yet, if the plate used is small, there may be no need at all in taking up the extra time.

Under certain circumstances, such as color plates, absolutely accurate register, necessity for mathematical correctness in size, etc., a prism is used in photographing, to save any shrinkage or distortion that might arise from turning the film. The meaning of this term will be explained later, it is only needful to say now that all negatives must be turned so they will print backwards upon the metal. A prism of regular form is shown in Fig. 6. The method of operation is to screw the prism on to the front of the lens, and turn the camera sideways to the copy, at right angles to the regular method of photographing. It will be seen that the top and the bottom of the prism are right-angled triangles, with the lens in one side; the opening in the other side screws into the front board of the camera; the hypotenuse is a finely silvered mirror on its inner side. The image of the copy is projected back through the lens on to this mirror, where it is, of course, reversed, and from here it is thrown back through the other opening on to the sensitive plate. This method eliminates the necessity of turning the negative, but has the disadvantage of only



PHOTOGRAPHIC EQUIPMENT

Fig. 6. Prism.—Fig. 7. Copying Stand.—Fig. 8. Plate Holder.

allowing the printing of one negative at a time, instead of a big "flat." The rectangular side shown in the illustration screws into the front board of the camera. The glass used for photographing with a prism must be perfectly flat, and heavy enough to stand the pressure of the printing frame.

The Camera Stand. A very necessary part of a photographing outfit is a proper camera stand. There are many forms of these, but the one shown in Fig. 7 is probably as good as any and is the one generally chosen unless extra size or extra weight cameras are used. The first requirement is entire rigidity and strength, and absolute trueness of line and surface. The lower part is built strongly and heavily, and is really only a carriage for the upper portion, the part upon which the camera rides. This upper part is attached to the lower half by means of four spiral springs, one of which is fitted over each leg, and on these springs the weight of the upper part and the camera is carried. The object of hanging upon springs is to insure each part moving in unison if suddenly shaken or jarred. The camera is laid upon the upper horizontal sides, and held in place by grooves into which it fits, and where it is pulled back and forth to get the proper size and focus, the lens facing toward the copy board at the far end. The copy board must be absolutely perpendicular to the top of the stand, and must be rigid, strong and true, or it will not be parallel to the sensitive plate, in which case the image will be distorted and

out of shape. The copy to be photographed is fastened upon this board, and so faces the lens in a perfectly parallel position. It must lie flat upon the board, and there must be no creases or wrinkles upon its surface. Some operators do not tack the copy directly upon the board, but prefer to use an extra board, hanging it by a cleat from the top of the stationary one. In case a copy is wrinkled or does not lie flat it is laid upon this extra board and a sheet of plate glass placed upon it, the whole being held in place by some fastening device. The interposition of the glass has no effect upon the quality of the negative. Occasionally a large paper printing frame, such as is used in ordinary photograph galleries, is used in place of plate glass.

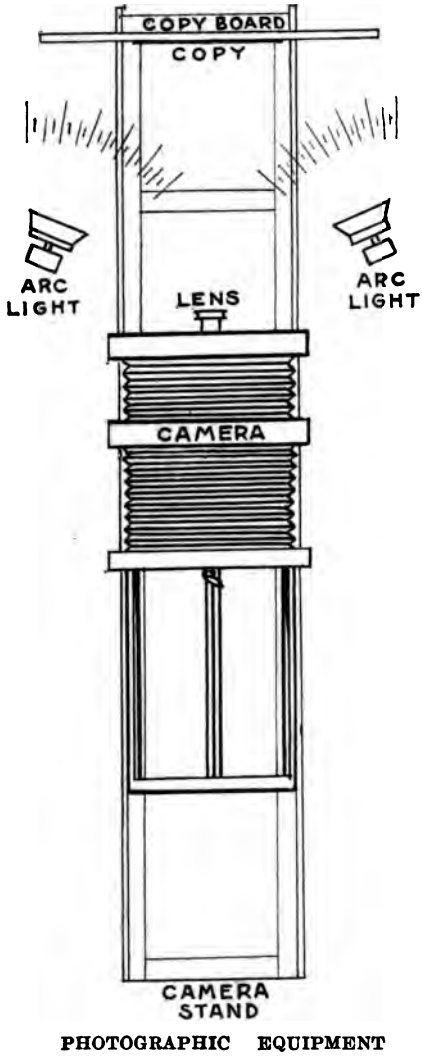
The Plate Holder. The method of exposing the sensitive plate to the image which the lens projects upon it is by a plate holder, Fig. 8. This plate holder fits upon the back end of the camera in place of the ground glass, and is a light tight box, with a door at one side and a slide at the other. The bars shown in Fig. 8, extending from one side to the other, marked A, are fitted with little metal disks, against which the plate is laid, the upper one being generally a plain piece of wood easily moved up or down, but the lower fits into the slots shown in the sides and is moved up or down according to the size of the plate that is to be used. It is usually grooved to catch any silver draining from the plate and sometimes has a trough imbedded in it for this purpose. When the

plate is in, sensitive side turned away from operator, the door is closed and the spring fastened to the back of the door presses it tightly against the metal strips, holding it firmly and solidly. The exposure is made by removing the slide, which is shown partly opened in the cut. The plate holder must be absolutely light tight, not only in itself, but also at the joint where it fits into the camera. Here it must be true and snug, the bottom generally fitting on to two pins, and the top held tight by a strong spring.

It will be noticed that there are two sets of bars running across the plate holder, those marked A being the ones that hold the sensitive plate, and are all that are used in line operating, but for half tone work some arrangement is needed to carry the screen, which has to fit in front of the plate, and through which the copy is photographed. This is shown in Fig. 8 by the two bars marked B, which have metal holders to support the screen in place. The screen must be absolutely parallel to the plate, and as various size screens are used, these bars are also adjustable vertically. As the distance between the plate and the screen must vary with different classes of work and coarseness of ruling, there is always some mechanism to graduate it, in Fig. 8 it is the little thumb nut at top, marked X, though there are various devices used. When the camera is being used for line work these bars are pushed out of the way of the exposure.

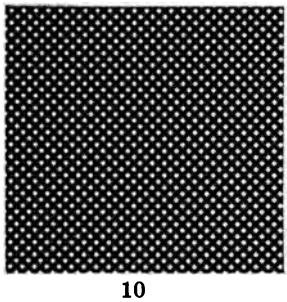
Arrangement of Lights and Camera. In Fig. 9 is shown a diagram of the manner in which the lights are usually placed and their relation to the camera, drawn from above. This position is, of course, not absolute, varying greatly with the size of the copy and the work, but it shows a normal condition, and, under any circumstances, the lighting of the copy must be true and even. With a small copy they can, naturally, set closer than they can with a large one.

Half-tone Screens. There are several kinds of screens, but those principally, rather almost exclusively used, are the regularly ruled line grating, Fig. 10, and the mezzograph, Fig. 11, which consists of dots and lines, irregular in shape, size and position. (These two figures are enlargements of the rulings and dots, and are much coarser than the average screen.) Of these, the ruled grating is by far the most popular and feasible for the ordinary run of work, and is used much more than the other, which is only kept for some special work or purpose. Both come in various degrees of coarseness. For the remainder of this book the ruled grating will be the screen that is understood, and all references to screens will be given with it in mind, unless otherwise stated. The manipulation of the mezzograph differs from it principally in the fact that the distance between the mezzograph and the plate is very small, and, in fact, is usually reduced to as close and fine a space as possible. The separation distance on ordinary half-tone, or ruled



PHOTOGRAPHIC EQUIPMENT

Fig. 9. Diagram showing position of Lights, Camera and Stand.



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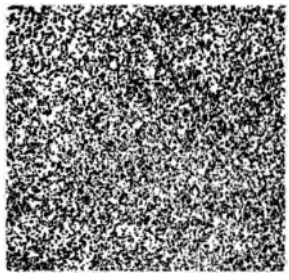

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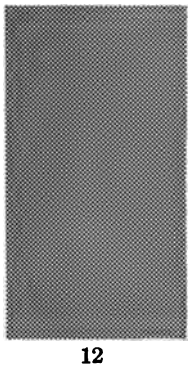

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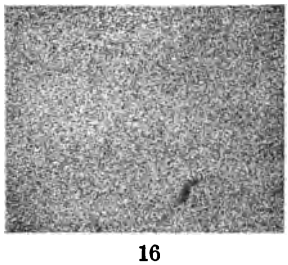

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PHOTOGRAPHIC EQUIPMENT

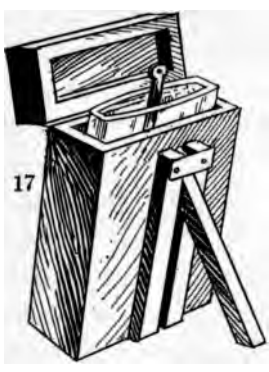
Fig. 10. Ruled Line Screen (enlarged).—**Fig. 11.** Mezzograph Screen (enlarged).—**Fig. 12.** 60-Line Screen.—**Fig. 13.** 120-Line Screen.—**Fig. 14.** 133-Line Screen.—**Fig. 15.** 175-Line Screen.—**Fig. 16.** Mezzograph Screen.

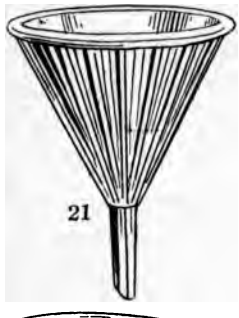
screens varies considerably; a larger separation giving more contrast, less separation more detail. It is possible to use more separation on a coarse than on a fine screen, as the lines are naturally coarser and heavier. Screens are generally ruled so that the black surface and the white will be even in quantity, and are designated by the number of lines to the inch. Fig. 12 is a sixty-line screen, the standard for newspaper work, though some papers use eighty and even one-hundred-line. Fig. 13 is one-hundred-twenty-four-line, generally used for publications of better printing and quality than newspapers, but not enameled stock—many of the advertisements for magazines are made one-hundred-twenty-four. Fig. 14 is one-hundred-thirty-three-line, and is the most popular screen of all, printing fairly well on any good book paper. Most of the half-tone illustrations published are made with this screen, which is open enough for nearly all kinds of book work, at the same time it is fine enough to get most of the detail in the average picture, and yet the dots and lines are strong enough in the etching to stand a fairly deep "bite" and so get good printing depth, a very desirable attribute. Fig. 15 is a one-seventy-five-line screen, and is altogether too fine for ordinary use, it requires high-grade enamel stock to print on, the best of ink and very careful make-ready, and is only used where the cost of printing is not considered. Fig. 16 is a mezzograph.

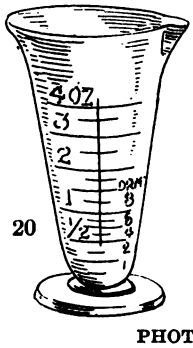
All screens are very expensive and require the best of

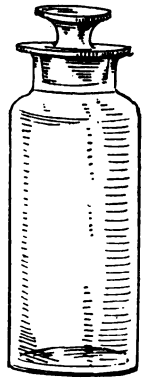
care, a small scratch or blemish marring their usefulness greatly. When first taken out for use, they should always be cleaned and polished with a chamois or piece of absorbent cotton; handled very delicately, and never dried by artificial heat, which is liable to make the balsam, with which they are sealed together, bubble.

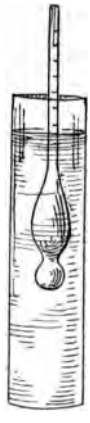
All screens are made of two pieces of glass, of the finest quality, sealed together with Canadian balsam, and with the exception of the mezzograph screen, whose manufacture is somewhat more complicated, they are ruled very carefully by machinery. In the early days of photo engraving, many screens were photographic negatives copied from paper ruled in sheets, and the first of them were only ruled one way, viz., without any cross lines. If a cross line effect was required, the plate holder had to be taken into the dark room and the screen turned around, a very delicate operation. At the present time, there are two types in popular use, one where the glass is covered with an opaque ground and then ruled so that the ground is removed along the lines ruled, and another type where after the ground is removed, the glass is etched, the ground removed entirely, and the etched lines filled up with an opaque substance. The latter are the best, costing about fifty per cent more than the plain ruled and work much more quickly and sharply, though, for general purposes, the cheaper ones are quite satisfactory. All screens are carefully bound around the











PHOTOGRAPHIC EQUIPMENT

Fig. 17. Bath Holder.—Fig. 18. Plate Dipper.—Fig. 19. Hydrometer. —Fig. 20. Graduate.—Fig. 21. Funnel.—Fig. 22. Salt Mouth Bottle.— Fig. 23. Mortar and Pestle.

edges, principally to prevent silver or other moisture from creeping in and injuring them.

The Bath. A typical bath holder is shown in Fig. 17, the glass portion which contains the silver fits into the wooden box, which not only protects it from accidents and keeps out the dust, but also makes it light tight, and keeps the plate from becoming light struck while the silver is being deposited upon it. If necessary, for experimental or other work, the bath can be put into a tray, but a regular bath holder, together with the wooden cabinet that encloses it, is much the best.

The Dipper. When the plate is ready for the silver bath, it is lowered into it by means of a plate dipper, Fig. 18. This is usually made of hard rubber, and the plate, film side outward, rests upon the two buttons at the bottom of the Y while being lowered into, and resting in the bath. If the bath is dirty, care must be taken not to stir up the bottom, or disturb it with the dipper.

The hydrometer, Fig. 19, is an instrument used for measuring the amount of chemical in a liquid. Standing zero in distilled water, it floats higher as more chemical is added, standing at 10° with a certain proportion of silver or other chemical, 20° with twice as much, and so on. While it is possible to do without it, it is very useful and saves much time and trouble. The hydrometer usually consists of three parts, a wooden box for holding it safe, the hydrometer proper, and a glass tube

into which the liquid to be tested is poured. Fig. 19 shows this tube with the liquid in it, the hydrometer floating in the latter. The scale is on the thin part of the instrument.

A graduate is a glass, usually of the shape shown in Fig. 20, and is used to measure liquids, being marked off in ounces, etc., along the sides. It is almost indispensable, and if the graduate is ever used for iron, it should be washed very carefully before being used for silver. Far better practice is to keep one for silver only. They come in various sizes, from a few minims up to thirty-two ounces or over.

Funnels can be bought in various types, but the fluted funnel, Fig. 21, is the most preferable, as liquid will flow naturally down the flutes or ribs. A funnel which has no ribs on the portion that fits into the neck of the bottle will not filter well, because there is no escape for the air already in the bottle, and as the liquid keeps filtering down, it is apt to bubble and run over. If a smooth funnel is used, put a bit of string between shank of funnel and the neck of the bottle, and so provide a space for the air to escape.

The regular filtering medium of the process worker is absorbent cotton, a pledget being stuffed in the neck of the funnel, fairly loose (or a thick solution will not flow through it), and the chemical to be filtered strained through. As a general rule this is very satisfactory.

Most photographers prefer salt mouth bottles with

wide necks for their chemicals, as Fig. 22. They are much better than narrow-necked ones closed with a cork, as they can be cleaned much more easily. Rubber stoppers are better than corks.

Some chemicals are very solid and hard in substance, and if left in their original crystals take a long time to dissolve. To hasten their dissolution they are crushed in a pestle with a mortar, Fig. 23. Both mortars and pestles are made of various materials, but glass is the best, as it can be readily and thoroughly cleansed, and there is little fear of contaminating the next chemical used.

Various kinds of glass are advised and advertised for negative making, but a good grade of window glass is generally used, unless for special work.

Plenty of water is an absolute necessity in every branch of photo engraving, and the photographer must have it very handy, with a good-sized sink, for he uses it continually in his manipulations, and there are times, as in developing or cutting, when five seconds may be a matter of importance. A small tobacco bag is usually fastened over the mouth of the spigot to prevent splashing or other trouble.

The same types of funnels, graduates, etc., found in the photographic room, are used by the printer and etcher.

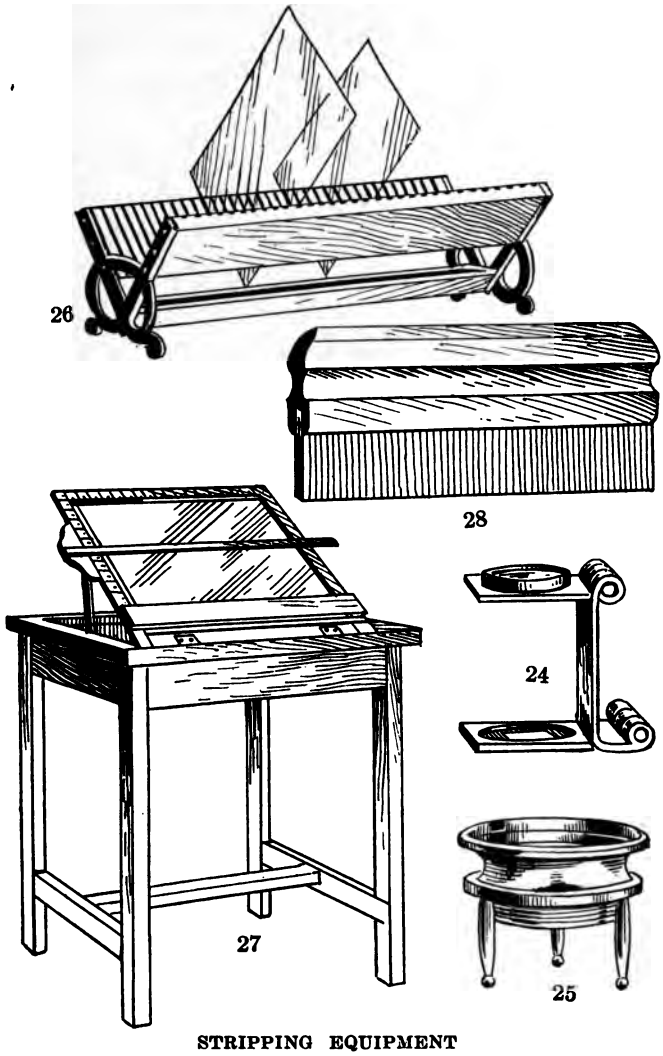
The big majority of sinks in process houses are simply square wooden tanks, bolted strongly together, and

lined with tar, pitch, or some other waterproofing. The waste pipe usually extends for two or three inches above the bottom so as to eliminate any chance of sediment, cotton, etc., going into the pipe and stopping it up.

The Use of Magnifying Glasses. One of the necessary tools for an operator, or, in fact, for any process engraving workman, is a proper magnifying glass. It is practically impossible to do without it, because of the smallness and fineness of so much of the work. In the case of a half tone, for example, of say one-hundred-fifty-line screen, the "scum" or "fuzz" around the edge of each dot must be cut away, or the negative would be useless, and for this work a glass is imperative—it would be utterly impossible to see whether it had been cut clear or not with the naked eye. Fig. 24 and Fig. 25 show two types of magnifying glasses that are very popular with engravers. Fig. 24 is a linen tester, and is quite powerful and very handy, folding up so that it fits readily in the vest pocket. Fig. 25 is known as a tripod magnifier, and is much used for focusing, etc. It is preferred for some things to Fig. 24, because it covers a larger field and dots can be seen in a larger combination.

Not only the operator but every other engraver should be equipped with a magnifier of some description to examine carefully the dots and lines.

Fig. 26 shows a negative rack, of which there are many variations, in detail, though the main shape and principles of construction are the same, viz., two oblique



STRIPPING EQUIPMENT

Fig. 24. Linen Tester.—Fig. 25. Tripod Magnifier.—Fig. 26. Negative Rack.—Fig. 27. Stripping Table.—Fig. 28. Squeegee.

sides, close at the bottom, wide apart at the top, with some kind of slots into which glass may be set and which will hold it firmly. These slots are sometimes made of corrugated metal, and sometimes are merely saw cuts in wood, but they must be far enough apart so that the negatives will not touch when placed in them.

What Enlargement or Reduction Means. When reading of enlargement or reduction in relation to photo engraving, one dimension only is considered, not area. For example, if a copy eight inches wide by four high is given to the operator, with instructions to reduce one-half, he measures one eight-inch side and reduces it one-half, or four inches. This will make a cut four inches by two inches, which will be only one-quarter of the area of the copy, yet, according to engraving house rules, it is reduced one-half. If the same copy is to be enlarged twice, he will make an eight-inch side sixteen inches, if three times enlarged, it will be twenty-four. This rule is universal and never varies; enlargement or reduction is always figured on one side and never on area.

Photographic Formula

Photo engraving, whether half-tone or line, starts with the negative, and the negative depends upon two things, the skill and experience of the operator and certain chemical formulas. The latitude in formulas is very great, and the same goal can be reached from many

directions, but experimentation does not pay a beginner. Choose the formula you wish and keep to it; do not keep changing from one to another.

There are many little things that may seem unnecessary, and others that may seem unduly complicated, but very few of them will benefit from change, and none without due thought and much deep regard for the purpose they are to fulfil, and the things they are to accomplish. Do not forget that the average intelligence of those engaged in the engraving business is very much higher than that of those in other trades, that this intelligence is being used continually along the lines that follow, and that it is on the *qui vive* six days in the week to better any of the processes, or methods, or formulas already in use. The bane of the beginner is a wish to improve upon what is being taught—do not fall into that error, wait until you have become familiar with the chemicals, their combinations and workings before attempting any changes or improvements.

Do not forget that the formulas given are standard, and such as are used by process engravers the country over; that each chemical has its meaning, use, and proper place in the formula, and that even the method of mixing these chemicals has a great effect upon the final result.

Principles Are Fixed. Small things are continually being changed in process engraving to save time or to save this or that, or to do better work, or what not; nevertheless the principles and main methods of work

change very little; most of the formulas given in this book have been in use for twenty years, many of them even longer, and it does not seem possible to improve on them. Accept them for what they are, and for what they will do; use them with confidence and security, and, if they do not answer in the manner you wish, be sure that the fault is with yourself, for hundreds of men are using them all over the country and producing results.

The base of all process work is the negative. Without a good negative a good engraving is impossible. It is the first step in the series of manipulations that is to reproduce the copy in the form of a printing plate, and it must be right, for all further effort is built upon it, and the final result goes back to it in no uncertain manner.

To the average person the taking of a photograph is the placing of a plate or a film in a camera, and pushing a button or pressing a bulb. This is dry plate photography, and is very different from that used in process work. Dry plates are seldom or never used, for two or three reasons; firstly, because of the expense, and secondly, because of the difficulty in obtaining absolutely clear glass, dense background, and perfect sharpness of edges and lines, and, thirdly, because of the waste of time. The photo engraver uses the old wet plate method, the original invention of Daguerre, which may be separated into three parts, or processes, or formulas, viz., the collodion, the silver bath, the developer. This

last is again divided into developing, cutting, and intensifying, but they are really all parts of the one operation and will be so considered.

The theory of wet plate photography, roughly speaking, is that a glass plate is coated with a sensitive collodion, and deposited in a silver bath for a certain length of time, whereby the collodion on the plate takes up silver changing the metallic iodides, etc., into iodides and bromides of silver, which are sensitive to light. This plate, after exposure, is developed, that is, brought out so as to be visible to the eye, fixed and intensified.

As collodion is, in a way of speaking, a kind of thin skin, and as all manipulations are to work upon, or change this "skin" in some way or other, it follows that it must be fixed to the glass and not be allowed to travel away or slide off. To prevent the film sliding, the glass is albumenized with the following solution:

Water, 32 ounces
White of one egg
Aqua Ammonia, 1 drm.

Thoroughly beat together, flow over glass, and stand in a rack to dry. When dried it is ready to receive the collodion. A number of plates are generally albumenized at one time, and used as required.

The Collodion

Collodion is a substance composed of ether, alcohol, and gun cotton. Gun cotton will not dissolve in either ether or alcohol, separately, but will readily do so in a mixture of the two.

There are various kinds of ether, but sulphuric ether is the kind used in wet plate photography, and a certain amount, say eight ounces, is mixed with an equal amount of pure grain alcohol, and then gun cotton is dissolved in the mixture. This makes plain collodion, and quantities of it are sold in tubes as liquid court plaster. Plain collodion will not work, however, as a sensitive base for nitrate of silver, and various other chemicals must be added to give it the necessary sensitiveness to light, after it has been soaked in the silver bath.

One of the best known formulas for sensitive collodion is made up as follows:

Plain Collodion
Sulphuric Ether, 11 oz.
Absolute Alcohol, 9 oz.
Gun Cotton, 110 grains.

(These constituents are somwhat dangerous if handled carelessly. Sulphuric ether is used as an anesthetic in place of chloroform, and gun cotton is one of the most violent explosives known. All of them should be guarded carefully against fire.)

Iodizer

Iodide Ammon,	60 grains
Iodide Cadmium,	60 "
Chloride Calcium,	15 "
Alcohol,	2 oz.

Dissolve the chemicals, then add to the plain collodion and shake well.

Another formula is as follows:

Plain Collodion

30 oz. Alcohol
32 oz. Sulphuric Ether
320 grs. Gun Cotton

Iodizer

2 oz. Alcohol
208 grs. Cadmium Iodide
128 grs. Ammonium Iodide
40 grs. Strontium Chloride
40 grs. Calcium Chloride

Both of these formulas are good, but it will be seen from a comparison of the chemicals used in the iodizer what a wide range is allowable. It is not necessary for the photographer to mix his own iodizer, unless he wishes, for, if such a method is preferred, it may be purchased with the component parts, except the alcohol, already mixed, and simply added to the collodion.

Up to a certain point an excess of alcohol in the collodion gives greater sensitiveness and density, but too much will give a tender, porous film.

An excess of ether will give a strong, contractile film.

When first made, the mixture is a light yellow in color, and cannot be used successfully; it must "ripen" before being fit for use, and its color is then a rather rich, lightish-looking red, or deep orange. If it is allowed to become over "ripe" it turns to a color something like red wine, and it is then useless, as it makes a rotten film. This is quite apt to occur in summer time or in a hot climate, and must be guarded against by only mixing a comparatively small portion at one time. Most photographers keep a little "ripe" collodion on hand, and, when making new, add some of the old to it to hasten ripening and so make it fit for use. Always filter carefully before using.

The Silver Bath

The silver bath is, possibly, the most important one thing in process engraving. Substitutes might be found for other manipulations, but the silver bath is absolutely necessary. It is also the greatest source of trouble, and most of the worries that the photographer has are connected in some manner with the silver bath. Because of this, two or three baths are generally made up, and as soon as the one in use shows signs of deterioration or

weakness, it is taken out of the holder and another one substituted for it.

The composition of the silver bath is very simple, viz.:

Distilled Water

Nitrate of Silver. (Enough of this is dissolved in the distilled water to test 40° on the Hydrometer.)

A few drops of Nitric Acid C. P. (Enough to turn blue litmus paper red.)

It should now be slightly iodized. This is done by flowing a plate with collodion, placing it in the bath and allowing it to stand there some time, from an hour or two, to all night. The bath is then ready for use. It may be used in a covered tray or such, but is mostly kept in a glass bath holder, Fig. 17, the collodionized plate being let down into it by means of a plate dipper, Fig. 18. The plate should soak for about four minutes to allow the requisite amount of silver to deposit on it, after which it is taken out, drained, placed in the plate holder of the camera and exposed. As the bath is used it gradually becomes weaker in strength, because of the deposition of silver upon the plates, and each succeeding plate must be allowed to stay in the bath a longer time to take up enough silver to make a good sharp negative. The plate may be flowed with collodion, and placed in the bath in daylight, as the bath itself is not sensitive to light, and the plate is not yet coated. When

the plate is removed, however, to be put into the holder, the room must be dark, for the emulsion is then sensitive to light, and is exposed to the copy in this condition.

Sensitiveness to Light. Wet plates are by no means as sensitive to light as are dry plates, and while the dark room should be tight, it need not be as hermetically sealed as is needful for the latter. The light used to work with need not be dim either, for the wet plate is almost as insensitive to yellow as it is to black. An ordinary electric light back of an orange or deep yellow glass is excellent, or even behind a ground glass covered with a couple of sheets of orange paper. It is even possible to work with an ordinary drop light with a few sheets of orange tissue paper wrapped around it, though glass is better. If there is a suspicion, at any time, that the light is too bright, add a couple of sheets of orange tissue to the covering.

In the formula for mixing the silver bath, distilled water is given, because there are very few places in the country where ordinary water can be used. Iron particularly must be avoided, though for that matter so should every other chemical. Ordinary city water is almost impossible, for even if free from iron and chemicals it is liable to be dirty and have impurities in it that will make fog on the plate. Also a silver bath gets dirty from use quickly enough, without giving it any help with impure water.

C. P. nitric acid must be used for the same reason.

Ordinary commercial acid will not do for the silver bath, as there are too many impurities in it.

Grease must never be allowed to contaminate the silver bath.

The bath deposits according to the amount of silver in it. As stated, a bath registering 40° deposits in about four minutes, but, as the bath gets weaker, the plate must be allowed to stay in it somewhat longer. A bath can be worked quite low, as low as 20°, if clean, and if it has not become too full of iodides from the collodion. After that it is not satisfactory and should be replaced by a new one.

Sunning the Bath. The silver bath is a very simple thing, but one of the most sensitive, and it will not stand rough usage. It must be kept covered when not in use, or dust, etc., will sift in, and later find its way on to the plate, where it will almost surely leave a pin hole in the negative. The bath is not sensitive to light while in solution, and must be combined with some emulsion (in this case the collodion) before becoming so. When run down, or when it becomes over iodized from the collodion, or dirty, or when it develops any other trouble, it is best to take it out of the holder, neutralize it with a little bicarbonate of soda, place in a large glass bottle, and set in the sunlight, leaving as long as possible. It is astonishing the amount of dirt that will settle to the bottom of the bottle; the longer it is sunned the better for the bath. Two or three weeks or even longer, if pos-

sible. Sunning never does a bath harm, and is very good for it. When it is required for use again, filter carefully, add what distilled water is needed to bring back to quantity required, drop in enough silver to bring the strength to 40° on hydrometer, acidulate it so as to turn blue litmus paper red, and it is ready for use again.

If the bath is badly overiodized, or has absorbed too much ether or alcohol, or the sun does not appear to be acting upon it, or there is not time to wait, it is oftentimes "boiled." This is a misnomer, evaporation is really what happens. The bath is neutralized, poured into a porcelain dish and placed over a gas stove. Just enough heat is used to make it simmer gently. The bath can be evaporated as far as required, even so far as to leave only the nitrate of silver crystals in the bottom of the pan. When satisfied that the ether, etc., has been boiled off, and that all the dirt is deposited, the flame may be turned off, bath allowed to cool, and distilled water and silver added to bring it up to the proper quantity and strength again. Then it can be returned to bath holder, or put into a bottle and "sunned" as usual until required for use.

Before sunning or boiling, the bath must always be made neutral, or even slightly alkaline, otherwise the desired result will not be obtained. It is customary to use sodium bicarbonate for this purpose, though some operators eliminate the acid with a few drops aqua ammonia.

The Developer

After the exposure of the silvered plate in the camera it is taken into the dark room and removed from the holder, and, seemingly, it is just the same as it was before exposure. There has, however, been a rearrangement of chemicals, from the action of the light as transmitted through the lens, and the work of the developer is to make this change apparent and to put it in shape for further operation. This is done by flowing over the exposed plate the following solution:

Sulphate of Iron,	3 oz.
Acetic Acid,	1 oz.
Water	32 oz.

Some operators add a little alcohol, about a small ounce, to the developer, so that it will mix more readily with the film, especially if the bath is old or over-iodized. It prevents streakiness, and the developer amalgamates more readily with the film. A new bath does not need it, and alcohol always makes a tender film.

Many operators prefer to mix up the developer by hydrometer, and the following is a good formula.

Ferrous Sulphate (Sulphate of Iron) to register 24 on hydrometer.
Acetic Acid, 1 part to 12 of solution.
Alcohol as needed.

The image will slowly appear on the plate, in the form

of a slightly different tone to the body of the emulsion. The longer the solution is allowed to lie on the plate, the stronger the film will be, and the greater the contrast, but the more chance there is of "fogging" the lines.

The real developing agent is the sulphate of iron, and the more of this there is in the developer, the quicker it will act, and the more contrast will be obtained, always supposing the development is not carried to such an extreme that the parts of the film that should be clear glass are "fogged"—a technical term for semi-opacity. If developing was attempted with the iron alone, the image would flash up, arrive at the proper point, and speed past it with such rapidity that it would be beyond the power of the operator to control it. To slow down this action the acetic acid is used, and the more that is added to the solution the slower the action will be; it also has a tendency to prevent "fog."

The Latent Image. It is hardly possible to speak positively of what takes place in this action, except that it makes the image, already latent upon the plate, visible to the eye. The process that makes light act upon silver is not known with certainty, except that it is supposed to rearrange certain molecules, which the developer liberates, in the form of a metallic silver salt, by a combination with the collodion of the film, and this produces visibility of the image. The longer the developer acts, the more silver it is supposed to deposit in the

collodion, which, of course, makes the film denser; a rather labored explanation, but the best we have, and probably, in most ways, correct.

Fixing

As the developer only operates upon that part of the film upon which the light has previously acted, it is necessary to get rid of those portions that have been untouched, and so make the film permanent. This is done by a solution of

Cyanide of Potassium, 3 oz.
Water, 20 oz.

This forms a soluble compound with these untouched portions of the film, and, mixing with the water flowing from the water spigot, is washed off into the sink.

The operation is very simple, the solution being poured upon the plate and allowed to remain until the parts to be eliminated are dissolved, after which the negative is placed beneath the water and washed thoroughly.

This chemical is probably the deadliest poison known to chemistry, and while it can be, and, in fact, is generally handled with impunity, it is well to isolate it in some special bottle to prevent mistakes.

The Intensifier

After the film is fixed it is very thin, weak, and transparent, and of no value for printing purposes in

such shape; the body of the film must be made heavier and more solid, and impervious to the passage of light through it. This is accomplished by the deposition of chemicals upon the film, building it up, thickening it, and finally making it so that when held up to the light, it shows black, solid and opaque. At the same time, the portions removed by the cyanide must show as clear glass.

There are two recognized intensifiers, the mercury and the copper, and of these two, the latter is the one almost universally used. The mercury intensifier is undoubtedly the best for fine work, but does not make as solid or black a negative, requires very careful printing, cannot be manipulated or "cut" with as much ease, and has the objection of being very foul smelling. It consists of three parts, as follows:

The Bleach

Saturated solution of Corrosive Sublimate (Bichloride of Mercury).

If a little muriatic acid is added to the water it will take up more mercury.

This is flowed over the negative or can be put into a tray, and the plate laid in it until the film turns white, after which it is taken out and all loose mercury well washed off.

The film is then flowed over with a weak solution of nitric acid.

Water, 10 parts
Nitric Acid, 1 part

after which it is again well washed and then blackened.

The Blackener

Hydrosulphuret of Ammonia
Water

This is usually flowed over the plate from a bottle and run back into the bottle, which is kept tightly corked, because of its utterly vile odor. It turns the negative a dark color, but not quite opaque.

The copper intensifier is much more popular, handy to use, and gives a dense black and white negative, the dark parts being solidly opaque, and the light parts clear glass. It consists of two parts,

The Bleach

Bromide of Potassium, ½ oz.
Sulphate of Copper, 1½ oz.
Water, 8 oz.

The Blackener

Nitrate of Silver
Water } To test 40 on hydrometer.

Cutting and Clearing. The plate is bleached as with mercury, and well washed and blackened, then examined, and if not dense enough is bleached and blackened

again. It is then examined once more carefully, and if the glass is not quite clear, or shows signs of fog, it is "cut" or "cleared." A little iodine is put into a graduate or bottle, a small amount of cyanide is added, and the bottle filled up with water. The solution is flowed over the plate, and the iodine deposits on the body of the film, while the cyanide cuts away any fog or color from the portion that is to be clear glass. It is necessary to keep the cyanide weak, so that it will not attack the body of the film, and at the slightest sign of doing this, it should be washed off at once.

Some operators use a different method, flowing a solution of iodine or iodide over the film after the bleach, and then cutting with weak cyanide. A weak solution of any iodide may be used after the bleach, if preferred to iodine. This turns the film a light canary color, lighter than iodine, and gives considerable density to it. Some operators prefer a little alcohol in the cyanide when clearing a negative. Either method is good. After the film is cut it is once more intensified or merely blackened, and placed in the rack to dry, which ends the photographing portion of the process. Next comes the stripping.

Negatives Larger Than Camera. In case an engraving is required which is larger than the camera can photograph, or, in the case of a half tone, which is larger than the screen, the negative is made in two pieces, and joined by the stripper. This is usually simple enough if the

copy is in line, for it is comparatively easy to match up the two pieces of the negative so that the join will not be noticed in the finished cut. Where any irregularities show they can be readily tooled away by the finisher. If the negative is a half tone, however, there is a much more complicated piece of work ahead, for it is almost impossible to match a flat tint so that it will show perfectly even on both sides of the join, or so that the line of jointure will not be evident. A trifle more developing, a slight variation in the lights, a second longer exposure or even less with any particular stop, or a little more cutting when clearing up, will make enough difference between the two negatives, so that when placed together they will not match correctly in color. Some of the darker tones, where there are black cross lines, are very difficult to engrave in facsimile, and it would be almost impossible for a finisher to duplicate the mechanical screen effect. A black dot is much easier to imitate, though even this is very difficult if the tint extends over any large area. To eliminate these troubles as much as possible advantage is taken of any object which can be used to make the joining less noticeable, such as the trunk of a tree, the corner of a building, the lapel of a coat and so on. Because of this fact the line of jointure is seldom straight across the film, but will vary from one part to another, wherever advantage can be taken of some object that shows a sharp edge, or that will prevent

the join from forcing itself into too great prominence. When photographing, both negatives are made so that they overlap at the join, and in stripping, one negative is laid over the other and moved around until the objects on the overlaps register absolutely over each other. When the negatives show in this way, the water is squeezed from beneath with blotting paper, and a sharp knife is run down the line of jointure, the two overlaps are removed, and the negative is squeezed down as usual.

Photographic Troubles

Tender Films.	Too much alcohol in collodion; overripe collodion.
Weak Images.	Too much acid in bath; underexposure; badly lit copy; poor collodion; overripe collodion; weak bath.
Fogged or Veiling of Image.	Not enough acid in bath; not enough acid in developer; too much iron in developer; developer of too high temperature; plate holder or camera leaking light; dark room not light proof; overexposure; overdevelopment; light in dark room too bright; dirty plates.

Pin Holes or Black Specks on Films	Dust in camera, plate holder, dark room, or any place where it may settle on plate; dust or dirt in collodion; undissolved salts in collodion; dirty bath; over-iodized bath.
"Comets."	Undissolved particles of gun cotton in collodion.
Scum on Film.	Developer too strong; plate kept too long out of bath.
Wavy Lines on, or Streaky Films.	Overiodized collodion, or too much alcohol or gun cotton in it; collodion has not been flowed evenly over film; not enough alcohol in developer; collodion too thick, so that it settles unevenly or in waves; overripe collodion.
"Oyster Shells."	Dirt in plate holder, usually on carrying bar.
Greasy-Looking Plates.	Not long enough time in silver bath.

CHAPTER 3

STRIPPING, PRINTING, AND ETCHING

Stripping Equipment

THE stripper requires few tools, a frame for stripping on being the principal on. Fig. 27 shows one form of this frame, though there are various kinds. Some plants have a bench with a glass top and lights shining below it. Whether frame or bench be used, the top should be glass, preferably ground, with a light below, to enable the stripper to lay his negative upon it and see just where and what he is cutting. Some strippers have the top of the glass ruled off in inches so as to be able to see the exact size of the cut they are making. Accuracy in the work is imperative, particularly in half tone.

The glass on to which the negatives are to be stripped must be perfectly flat, and heavy enough to stand the pressure of the printing frame; one-quarter inch plate is generally used, and answers every requirement.

A sharp knife, salt mouth bottles to hold rubber and collodion (these are very volatile substances and evaporate quickly if left open), a tray to hold the acetic acid solution in which to soak negatives, to cut the albumen on the glass loose; together with a supply of blotters cut

about two inches square and a rubber squeegee, Fig. 28, and a negative rack, Fig. 26, are required. In the case of trays practice varies, not only in stripping but in other parts of the work; some use porcelain, some rubber, and some wood, in which melted coal tar has been poured to make the joints tight. The porcelain are the best looking, but the most expensive, and are always liable to breakage; the others are much rougher in appearance, but for practical work are just as good.

Stripping Formula

The Flat. One reason process engraving is quicker and more reasonable in price than any other method of cut making, is because it is possible to engrave a number of cuts together, with very little, if any, more expense than it is to make one. A zinc etching may be two inches square when finished, or two by three, or five by nine, and, if etched by itself would cost more to produce than the cut could be sold for. Instead of etching each cut separately, however, every negative is transferred from the glass upon which it was photographed, to another sheet of glass with a quantity of other negatives. This is known as "stripping," and the placing of the different negatives together upon the one glass, as "making up a flat." Work of a like degree of fineness is usually stripped upon the same flat, and a flat may have anywhere from two or three to fifteen or twenty separate cuts upon it, according to the size of the individual cuts

and also of the "flat." A common size of "flats" is fourteen by seventeen inches; another popular size is eleven by fourteen inches, but they may be any size, according to the amounts of negatives ready, or the capacity of the printing frame.

Protecting the Film. The negative, as it comes from the photographer is too thin and tender for stripping purposes; it needs to be made tougher and stronger before it can be removed from one glass to another. This is done by flowing the plate with "leather collodion." As this has a strong affinity with the film, however, and would spoil it if flowed over it, the latter must be protected, which is done by covering it with a solution of rubber. This can be bought ready mixed, or rubber cement may be diluted with gasoline, or it can be made from either pure gum rubber, or a rubber that is specially manufactured in large sheets.

Rubber Solution

Take a sheet of rubber, cut it into small strips, drop into a bottle with gasoline, and let dissolve,

or

Do the same with pure gum rubber,

or

Use rubber cement.

The first is best.

The solution should be fairly thick and viscous, yet thin enough to flow readily over the plate, and leave just a thin coating. Use only enough to protect the film from the collodion, and run the excess off at lower left-hand corner back into the bottle. If evaporation thickens the solution, add more gasoline.

The rubber coating must not be dried by heat, or it will bubble and make nasty spots upon the negative. If the drying is to be hurried, put in the wind from an electric fan.

After the film is rubbered, a collodion composed of the following is flowed over it.

Stripping Leather Collodion

Sulphuric Ether,	8 oz.
Alcohol,	6 oz.
Gun Cotton,	3 drms.
Castor Oil,	7 drms.

Flow this over, the same as rubber. This solution can be dried by heat, and if in a great hurry can even be set on fire, care being taken not to crack the glass.

The film is now tough and heavy, and protected against ordinary rough usage or handling, and as soon as the collodion is dry is ready for stripping.

A tray is kept filled with water and a little acetic acid, one part acid to ten parts water (this is for the purpose

of cutting the albumen on the plate), and the negative, after being cut down to the size required, is placed in this to soak. By this is meant that a line is cut through all superfluous negative with a sharp knife, leaving the part containing the work untouched. After soaking for awhile in the acid solution, or until the film is ready to leave the glass, it is ready for stripping.

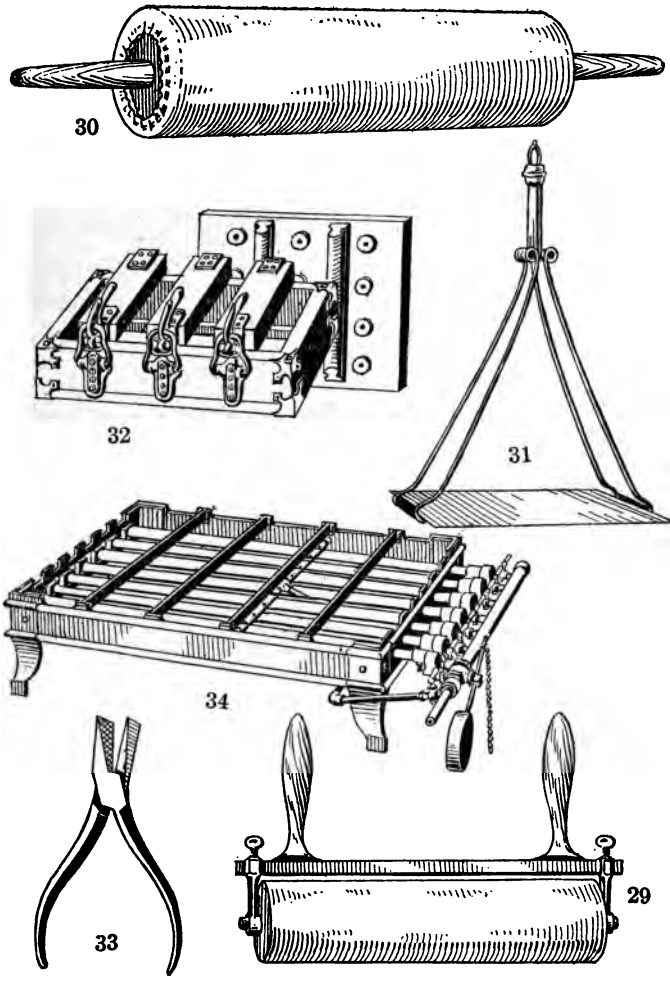
Making Up the Flat. Negatives are usually photographed upon ordinary window glass, free from bubbles and flaws, which answers very well for this purpose, but is too thin and frail for stripping purposes. Such glass is never quite flat, and is almost certain to break when clamped in the printing frame. One-quarter inch plate glass is generally used of a size that will fit easily into the printing frame, and these come in certain standard sizes, 10 x12, 11 x 14, 14 x 17, and so on, up to quite large dimensions. Choosing a piece of glass the size wished, it is placed on a bench or box with a glass top, Fig. 27, an electric light is adjusted under this top, which is usually of ground glass, for the purpose of diffusing the light. When the stripping glass is placed on top of it, everything that the stripper wishes to do is well lighted up and he can place the negatives in the exact form he wishes to make up the "flat."

The top of the stripping glass must be kept wet and the same applies to all the negatives going on the flat, until they are settled in place; otherwise they will stick,

or crumple, or probably tear. Taking the negative out of the acetic tray, the stripper washes off all loose acid, and lays it by the side of the stripping glass, then slipping a knife under one corner, raises it up and transfers it, turning it over as he does so. This is known as "turning" or "flopping" the negative, and is made necessary by the fact that the finished cut must be etched backwards to print straight in the press, and if the negative was not "flopped" the cut would be straight when finished, and would print backwards upon the paper.

Having turned the negative and placed it where he wishes it to come in the flat, he takes a little piece of blotting paper, a couple of inches square or so, and holding it edge down, goes over the negative and squeezes the water out from below it. Most strippers keep a supply of the blotters on hand, and as soon as one becomes wet, throw it away and get another.

When the negative is dry, another one is added to the flat and so on, until the latter is finished, or "made up." It is the usual custom, after all negatives are in place, to lay a piece of damp paper or some other sheet over the whole flat and go over the paper with a rubber squeegee, Fig. 28, to force the last water from below the negatives. As the flats must not be dried by heat either (the films are apt to curl off if it is applied), it is placed on the rack to dry, and as soon as it is firm and solid, is ready for printing.



PRINTING EQUIPMENT

Fig. 29. Brayer.—Fig. 30. Lithographic Roller.—Fig. 31. Whirler.—Fig. 32. Printing Frame.—Fig. 33. Pliers.—Fig. 34. Gas Stove.

Printing Equipment

The printer stands as the connecting link between the negative and the etching, printing the former upon the copper or zinc makes the latter possible. It is his business to transfer the negative impression to metal, and to put it into such shape that the etcher can go ahead with it and perform his part of the work. For this purpose he needs a certain equipment, some of which is made solely for him, and which is seen nowhere else. It is also his business to keep plenty of printing solution on hand, and to have this in shape and ready at all times for rush work.

A large bowl for mixing sensitizer is very necessary (and two are not amiss); one that will hold at least 64 ounces, or even twice that size, as the solution must be beaten to an absolute froth, so as to obtain a complete mixture.

An egg beater, one of the whirling type, is best for this purpose, a couple of graduates, 16 oz. and 32 oz., funnels and bottles are also required.

For zinc etching the print is made with an ink that is specially made for this purpose, and this ink is rolled out smooth upon a stone slab, or piece of zinc, from which the roller transfers it to the exposed print. A slab is best, and it should be of a fair size, say 14 x 21 inches, to allow for perfect distribution, and rolling out of the ink.

Inking Up the Print. For this purpose, many printers

use a composition brayer, Fig. 29, though others prefer a lithographic roller, Fig. 30, claiming that the composition rollers are apt to become "sticky" and "tacky" in hot weather. The lithographic roller is made of leather, and as the handles are solid and turn with the roller, they are usually grasped in two pieces of leather to save damage to the hands.

The Whirler. Copper half tones are not printed in ink, for several reasons, a solution of fish glue being generally used, which must be spread perfectly even over the surface of the plate. A special tool is used for this purpose, Fig. 31, which is known as a "whirler" from the manner in which it works, evening the solution by giving a whirling motion to the plate.

The Printing Frame. As most of the flats to be printed will average possibly 11 x 14 inches, and as the pressure must be thorough and even over the entire surface, it follows that a very strongly made and rigid printing frame is required. There are several types of these, of which Fig. 32 is possibly the most popular. The frame is made of very heavy wood, held together by metal clips and bolts; the bottom is usually a sheet of one inch to one and a half inch plate glass, without checks or flaws; the three cross bars are hinged and fitted with a device working upon an eccentric, to obtain the needed pressure; the back is also very heavily built, and the little round bosses shown upon it are pieces of heavy rubber, coming directly beneath the arms and supposed

to equalize the pressure. The number of cross arms varies with the size of the frame. There are many other types of printing frames to be bought, some working with screw pressure, and some by vacuum suction, but Fig. 32 is as good as any for the general run of work.

After the plate is printed it must be developed, dried, and in the case of half-tone prints, "burnt in." For these purposes a tray, a pair of pliers, and a gas stove are needed. Any style of tray, if large enough to take the print, can be used, or the latter can be developed beneath the water faucet. The style of pliers shown are what are known as wide nose, to get a firm grip on the plate, Fig. 33, and the gas stove must be capable of plenty of heat and have a flat surface. A good style is shown in Fig. 34, which gives a good even heat all over the stove. When drying or "burning in" the plate is moved about so that all parts of it get the heat alike.

Zinc, for etching, comes in sheets of various sizes and thicknesses, the size bought depending largely upon any special work a firm may do, or the size of their printing frames. It comes in two thicknesses, 14-gauge and 16-gauge; 16-gauge thickness is the one usually bought. The surface is polished and ready for the solution except for such grease as may have got upon it from handling; this is usually removed by a little French chalk and water, after which it is carefully washed and the water allowed to stay on the plate, so that it will take the sensitizing solution evenly.

Copper also comes in various size sheets, but the gauges are 16 and 18, 18 being the one on which most work is printed.

Printing Formulas

The method of printing upon metals for engraving purposes differs from printing on photographic paper, not only in manipulation, or in the result and effect obtained, but also in the chemicals used. Paper printing is accomplished largely with the chemicals employed in negative making, silver nitrate being the light sensitive chemical and the one that does the work. Metal printing uses a totally different chemical, one of an entirely different group, viz., the bichromates. (Gum prints, on paper, are made by use of bichromate, but they are not practical for the majority of negatives or the general class of work required.)

Zinc Printing. Bichromate of Ammonia is the chemical generally used for metal printing, though others have been used with some success; practically all printers, however, prefer ammonia, and it is almost universally used. The carrying medium is albumen, not collodion, and the formulas and methods for line and half-tone negatives differ greatly.

Sensitizing for Printing on Zinc

Water, 8 oz.
Bichromate Ammonia, 10 grs.
Whites of two eggs.

Crush the bichromate and dissolve in about one ounce of water, and while this is dissolving break the eggs into the remainder of the water and beat thoroughly together. This beating must be carried on until the mixture is like a mass of froth, otherwise the amalgamation of the water and albumen will be imperfect, and trouble will result. When thoroughly mixed, add the dissolved bichromate, and beat this into the mixture. This must also amalgamate perfectly. Then add aqua ammonia drop by drop, beating it in, until the mixture turns a light canary color, when it is ready for use.

The above is a very slow formula, useful for bad negatives, etc. A very fast one is:

Water, 16 oz.
Bichromate Ammonia, 20 grs.
White of one egg.

A medium speed can be obtained by varying the mixture, for example:

Water 10 oz.
Bichromate Ammonia, 10 grs.
White of one egg.

The thinner the mixture the quicker the print, as the zinc carries less and the light penetrates it more quickly. The object of the aqua ammonia is to help the unprinted portions to leave the zinc. Too much ammonia makes a weak, rotten print, that will not hold good or resist

the acid while it is being etched. Some printers prefer to leave it out altogether.

Filter the solution carefully and it is ready for use. In cool weather it will keep for some time in good condition, but do not forget that in all solutions where egg is used, the fact of the albumen going rotten is the controlling factor in the length of time they will keep. As soon as there is any suspicion that this has happened throw it away and mix more, for any print made with it will surely be unsatisfactory and weak, and is very apt to wash off in the etching.

Half-Tone Printing. Printing on copper is an entirely different affair from printing on zinc; in the first place, while the base of the sensitizing solution is the same, namely, albumen and bichromate of ammonia, other ingredients are added, and ink and rolling up is eliminated. For a screen of one hundred fifty lines to the inch, ink would be too coarse a medium, the dots would not be sharp and clear, and the whole cut would be muddy and obscure, instead of clear and sharp. An entirely different sort of solution is required. There are various methods of printing and developing, dry developing (in which the print is developed with a powder), gum arabic solution, and fish glue. Of these the most popular is the glue enamel, which is handier, less trouble to develop, and generally more satisfactory and reliable. A glue formula is given below and care is required in mixing it.

Printing Solution for Copper Half Tones

1.

White of Egg, 8 oz.
Water, 2 oz.

Beat well to froth.

2.

Le Page's Special Process Glue, 4 oz.
Water, 2 oz.

Beat well together and add to egg, and then beat egg and glue together.

3.

Bichromate Ammonia, 240 grs.
Water, 2 oz.

Add to glue and egg and beat well in.

4.

Chromic Acid, 40 grs.
Water, 12 oz.

Add and beat in, then add 12 drops aqua ammonia drop by drop, and then beat whole solution for five or six minutes, until thoroughly mixed. Filter and let stand over night before using.

Another formula is

Beat one egg to froth and add 6 oz. water. Then mix and add

Le Page's Process Glue,	2 oz.
Water,	1 oz.

Beat together and mix. Then

Bichromate Ammonia,	100 grs.
Water,	1 oz.

Add to above, then add a few drops aqua ammonia. Beat well and filter carefully into bottle. Do not use last inch or so of solution in bottle or print may scum.

Staining. After the print is made and before it is burnt in, the color is very similar to that of the copper below, and it is sometimes difficult to see whether the fine detail is "up" or not. To make it show plainer many printers stain it with a solution of

1 part Eosine or Methyl Violet dissolved in smallest quantity of alcohol to 20 parts water.

If any doubt remains after the plate is burned in that all detail is not thoroughly developed, plate may be rubbed over with a pledget of absorbent cotton, dipped in a weak solution of chromic acid, until the copper clears up. If it does not show plainly to the finest dot, then the print is under developed, or there is scum upon it and it must be made over.

Stripping, Printing and Etching Troubles.

Film refuses to leave glass.	Dirty glass; outside matter in albumen.
Bubble holes on film.	Drying rubber by heat; plate hot when flowing rubber.
Shriveling or shrinking film.	Flowing collodion on film without protecting it with rubber. Rubber solution too thin.
Scum on half-tone print.	Dirt in water left on copper when flowing sensitizer. Some printers claim that the last ounce or so of printing solution in bottle will scum if used. Insufficient mixing. Over printing. Poor contact. A print can sometimes be cleared up by saturated solution bichromate potash, 8 parts, sulphuric acid 1 part. Wash print in water and apply with cotton till copper sparkles. Probably the best thing to do is to print again. Albumen gone bad. Too much light on plate before printing.

Enamel will not stick in printing.	Enamel too thin; undertimed; rotten albumen; dirty plate; try whirling plate warmer; over burned in.
Smudgy ink prints.	Too much ink; too hard scrubbing when developed.
Weak ink prints.	Undertimed; poor contact; rotten albumen; too much ammonia in developer; ink too thin.
Thickening of lines in line etching.	Too much ink on print; overtimed; poor contact; too much topping powder on print; heating plate too much and spreading ink or topping powder.
Topping or enamel coming off in bath while etching.	Weak print; acid too strong; hot bath; too much brushing; removing plate too much and flowing too much water on it. (This is particularly bad for half tone enamel.) If enamel burns in gray looking, it is too thin and will not stick.

Etching Equipment

Etching is the final chemical process in photo engraving, for routing, beveling, blocking, etc., are largely mechanical in their nature, while finishing is a handicraft, a matter of individual tooling, elimination of spots, vignetting, etc., all done by hand tools. It is the etching that turns the flat piece of metal into a cut, that eats away unnecessary surfaces and stands up the lines or dots of the cut, the essential portions, the parts that perform the mission of duplicating the copy in the printed sheet. All other manipulations are preparatory to this, the final culmination of the series.

Like other portions of photo engraving, etching is divided into two parts, line work and half-tone, and, again, as all the way along, the line work is the simpler and will be considered first.

Zinc Etching

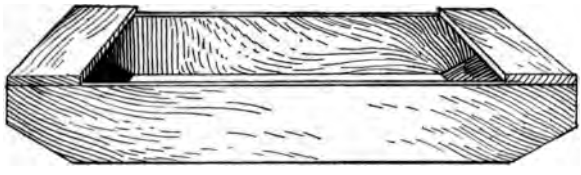
The Etching Tub. Zinc etchings are etched in a tub, usually rocked by power, though it is not at all necessary. A form of tub is shown at Fig. 35, and the average etching tub is simply a wooden box, with boards over each end to prevent splashing, and is lined with melted coal tar, to keep the acid from attacking the wood, though other kinds can be bought if wished. It usually stands upon a bench, a wooden lug of some kind being attached to the bottom, and is provided with a bolt or rod, which passes through another in the surface of the bench, and

with a hole at one end from which to drain the acid. Some tubs are placed upon stands specially built for them. When the rocking is to be done by power, an arm is run from one end of the tub to a pulley on the end of a shaft, or sometimes the tub is hitched to a little motor with a pitman shaft running from the pulley, as in Fig. 36.

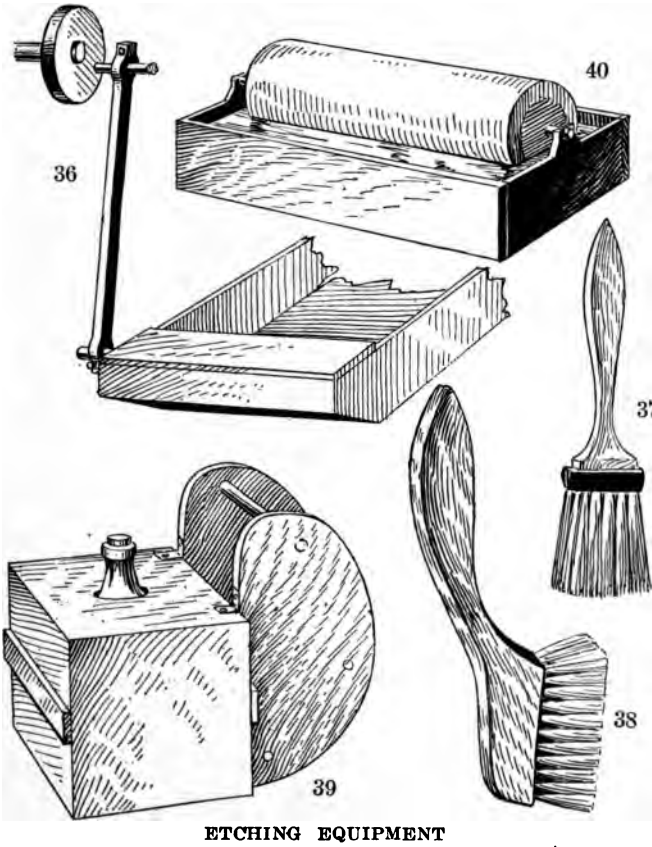
All zinc etchings are rocked while being etched, as moving acid cuts much faster than that of the same strength will do when still. This is largely because fresh acid is constantly being brought into contact with the exposed zinc, whereas, when the acid is still, the same acid will touch the same zinc spot all the time. Speed of movement in tubs will vary considerably, but the best speed is probably from twenty to thirty a minute; that is, the acid should reverse the movement each two or two and one-half seconds.

Topping. When the print is given to the etcher he dusts it over with a powder known as "topping powder" because, when melted, this puts an acid-resisting top upon the ink lines or dots. After one "bite" has been given the plate, the sides of the lines are usually protected by dragon's blood, which is brushed on with fine camel's hair brushes such as Fig. 37. It is necessary to have a few drawers or boxes of good size in the etching room, in which to keep topping powder and dragon's blood.

Zinc etching is generally done in a room by itself,



35



ETCHING EQUIPMENT

Fig. 35. Etching Tub.—Fig. 36. Power attachment for Etching Tub.—Fig. 37. Etching Brush.—Fig. 38. Plate-cleaning Brush.—Fig. 39. Carboy Rocker.—Fig. 40. Cooling Roller.

because of the fumes from the etching zinc, and also the dust from powder and dragon's blood. This is ground so fine that there is nearly always a coating of thin red dust on the walls of the room, and many etchers eliminate as much of this as they can by building a sort of shed around the bench holding the powder drawers, and brush the excess from the plate inside this shed. It does away with much dirt and dust.

In addition to powder brushes, others are used for brushing the metal deposit from the plate while it is in the acid tub, and these should be rubberset, because, no matter how well covered tin ferrules may be, the acid will surely attack them, and the brush will fall to pieces. Brushes will run from two to four inches wide, according to the work required of them, and should be well haired.

Clearing Up. A heavy stiff brush, or one made of metal wire, such as Fig. 38, is used for clearing up the plate after the etching is finished. Commercial nitric acid is the cutting acid used, and this is generally purchased in carboys, from which the etcher puts it into a pitcher for convenient use in strengthening up his bath. There are various ways of emptying the acid from the carboy, by pump, etc., but as good a way as any is shown in Fig. 39, where the carboy stands upon a pair of rockers. When acid is required, the pitcher is placed on the floor, and the carboy tilted upon the rockers until it runs out and into the pitcher.

A piece of chamois skin about a foot square is also useful to dab the surface of plates in order to eliminate moisture, etc., and a gas stove on the order of Fig. 34 is needed, for melting the powder.

Some etchers use a cooling roller, which can be purchased if desired, but a home made one—a piece of old carpet fastened around a spool or shaft, and placed over a box of water in which the lower part of the carpet runs, so as to keep it constantly wet, is just as satisfactory. The hot plate is run, on its back, up on the top side of this roller, which turns and brings the lower damp side in contact with the plate, cooling it off. Such a roller is shown in Fig. 40. Other etchers simply run water over the back of the plate out of the spigot, drying in with the chamois skin when cooled.

In addition to the above, a tin can of asphaltum for coating the backs of plates and a crock of lye to clean the plate when the etching is finished are needed, and an artist's fine sable brush with some etching ink in a little jar to spot any bad or weak places in the print, also a heavier one with which to paint in large open spaces.

Copper Etching

Half-tone etching on copper is done with chloride of iron instead of acid, and a tray is used instead of a tub, as the etching is done in still solution, not a moving one. The tray can be any size, depending upon the general

size of the flats to be etched. There should be an inch or two of leeway all around the metal. The trays may be of any substance—stone, rubber, glass, wood or whatever is preferred.

The copper plate is etched by placing the sides in two slotted pieces of wood, which allows it to go below the surface of the iron, at the same time holding it above the bottom of the tray; thus allowing it to be completely surrounded by liquid. These wooden holders are shown in Figs. 89 and 90, and they are simply pieces of wood with slots cut in them to carry the copper.

The half-tone etcher needs a chamois skin, tin of asphaltum thinned with turpentine, artist's sable brushes for spotting in bad places on the print, large camel's hair brush for cleaning the surface of the plate, a square of magnesia, and some larger artist's brushes for re-etching. These should preferably be of the Japanese type, where the hair is set in reed instead of tin, as the former is impervious to acid. A gas stove, and sink with running water are also necessary parts of the half-tone etcher's equipment.

There are two kinds of zinc used for etching, known in the trade as "hard zinc" and "soft zinc." Soft zinc is more nearly pure than the hard zinc, and is brighter in texture, and, generally somewhat higher in price. Most soft zinc is used in the eastern portion of the country, the middle states preferring the hard variety. The method of work is the same with both kinds, except

that, possibly, soft zinc etches a trifle easier than hard zinc.

All etching is not done by hand, for there are various machines that can be bought to do the work mechanically. These can only be used in large shops, however, and not all of these use them, as there is very little saving in cost of production or labor in the quality of the work. The great mass of etching is done in tubs, the amount of mechanical etching being almost negligible.

Etching Formula

There is very little formula attached to etching, as the baths for both zinc and copper may vary greatly without inconvenience. If too weak, more chemical should be added; if too strong, more water; experience will tell whether the mordant is cutting too rapidly or too slowly.

The first acid bath for zinc will run about one part of acid to twelve or fifteen of water. Few etchers measure this, however, testing it generally by taste. A finger is dipped into the solution and touched to the tongue. It should taste something like lemon, but with more of an edge to it. More acid is added to the bath with each successive "bite," how much can only be told by the speed with which it cuts the zinc plate. The general custom is to pour some in from the pitcher, wait a moment, then brush off the deposit on the bottom of

plate, and if not enough has been added, put in more. If too much, add water. Experience will tell almost accurately how much is required.

Asphaltum, for painting backs of plates should be thinned down with turpentine till it will work freely with a brush. It is too thick for use when first bought.

The lye in the crock for removing topping must be strong, as melted dragon's blood is difficult to wash off, and more lye should be added from time to time to keep up the strength.

The bath for etching copper is usually made up of perchloride of iron and water. About three pounds of iron crystals are dissolved in about one quart of water. Many etchers prefer to make up the bath by hydrometer test, in which case it should register not less than 35, and preferably not more than 45. Forty is a good average strength. An experienced etcher does not depend upon exact quantity in measurement, however, preferring to use his own judgment on the way in which the solution is cutting.

When the etching is finished it is necessary to clean up the copper, removing all iron and other stains, and this is done with a

Brightening Bath Solution

Water,	4 oz.
Acetic Acid,	4 oz.
Salt,	8 oz.

Pour over plate and scrub with a tooth or nail brush until copper shows clean in the spots between the enamel.

Overheated acid. Sometimes the acid in which zinc is being etched will become hot, and it has been known to get so warm that it will spoil the topping. The cause is the chemical action that takes place with the melting of the zinc, and usually results from attempting to etch too much surface in too small a bath. It must be cooled down, either with ice, or more water, and if this cannot be done, it must be thrown away and a new bath made.

CHAPTER 4

ROUTING, BLOCKING, FINISHING, ETC.

1. *Routing and Blocking Equipment*

Routing.

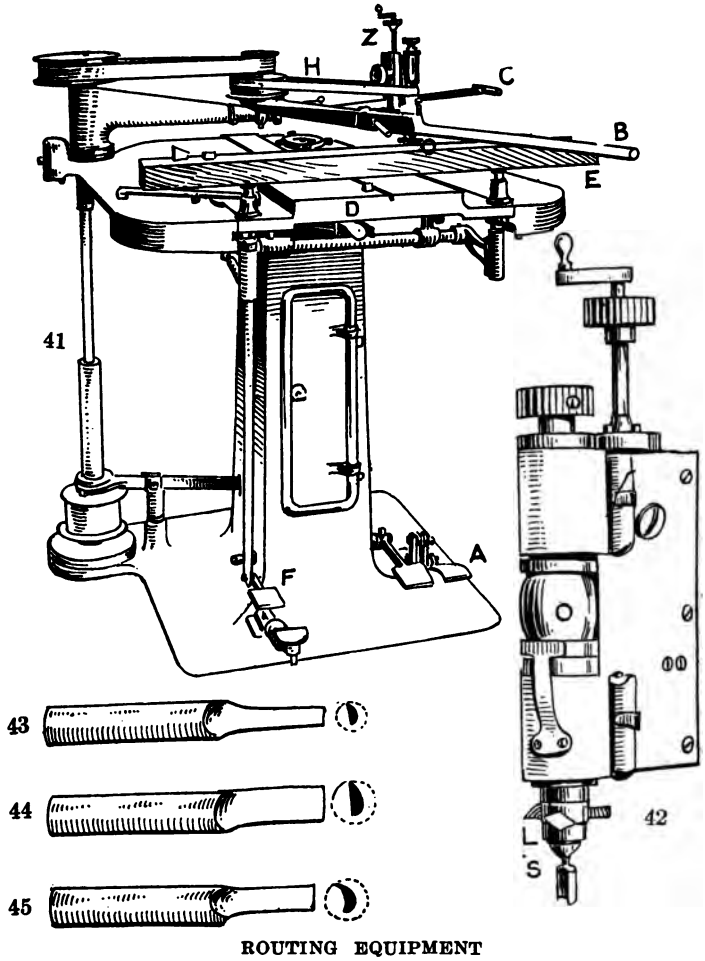
THE work of the router and blocker is done with a set of machines that more nearly conform to the general idea of machinery than any used in other parts of the photo engraving business. The most important of these machines, and the ones on which he principally depends, are the router, the beveler, the saw, and the trimmer. There are other machines in occasional use, for special purposes, etc., but the above four are the ones chiefly in operation.

Deepening the Cut. Because of the comparatively shallow depth of etching on a zinc plate, the larger places, if left as they come out of the tub, would "bottom" and print up, or "smudge" on the printing press, and it is for the purpose of deepening these places that a router is used. Ordinary half-tone, or square finish half-tone work does not demand it, but in vignettes and cutouts it is used the same as for zinc etchings. In the latter, as soon as a flat proof is pulled and the etching

is seen to be satisfactory, the plate is given to the router and he proceeds to deepen all places that are not deep enough already.

The Routing Machine. The routing machine is shown in Fig. 41, and it may be either belt driven from a shaft, or run by direct attachment to an individual motor, and all the other machines run by one of these same methods. The pedals shown on the right are for starting and stopping. One requirement of all routers is that they shall be solidly built to stand the strain of the great speed at which they run, and that the machine shall be free from vibration within itself. The direction of the routing tool, which is fixed in the head Z is governed by two arms, B and C, one of which is held in each hand, and because of the ingenious manner in which they are joined in the rear can be directed to any part of the table. The tool placed in the head routs the plate at the point to which the arms take it (a small tool, of course, is used for a little space, a big one for a large space) running back and forth and deeper, as needed, till the plate is the required depth, and the routing is finished.

The plate to be routed is usually tacked up on a wooden block and laid upon the bed of the machine, where it is fastened and held securely by a movement of a lever, the handle of which is shown at D. The router tool, being held solidly in the head of the machine, cannot, of course, change its cutting depth, and, as it is



ROUTING EQUIPMENT

Fig. 41. Radial Arm Routing Machine.—Fig. 42. Head of Routing Machine.—Router Bits.—Fig. 43. Soft Zinc, Wood, etc.—Fig. 44. Hard Zinc.—Fig. 45. Copper.

very necessary that large spaces should be routed deeper than small ones, this depth is controled by the bar E, which rises or falls according to pressure put on foot lever F, the arm B rising or falling with it. The head, Z, being attached rigidly to the arm routs deeper as it sinks lower, or shallower as it rises.

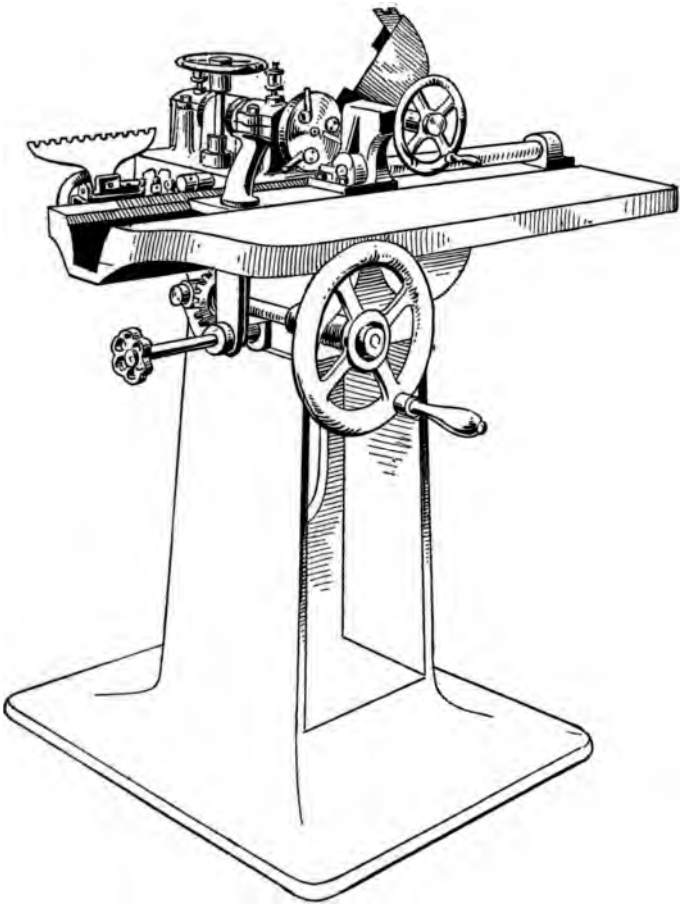
The Head. The head of the router, Fig. 42 (Z on Fig. 41) is the most important part of the machine, and is the portion that actually does the work, being, in some ways, a marvelous piece of machinery. Every portion of this head must be of the finest quality of metal, for it runs at the enormous speed of from twelve thousand to fifteen thousand revolutions per minute. The spindle pulley O is driven by the belt H, in Fig. 41, which is usually a special linen fabric, woven to stand the violent strain to which it is subjected. The knurled wheels, etc., on the top of the head, are adjustments for various purposes, tightening up the router bit, etc., while the router tool S is shown at the bottom, where it revolves and cuts. The two little blades marked L are parts of a small fan, which revolves with the bit, and keeps the part of the plate being routed free from chips and dust. Most routers have an electric light fixed to the head, to throw the light directly upon the work, and enable the router to see the finest details.

Routing Bits. Routing tools, or "bits," as they are usually termed, are made in various styles and sizes for cutting small or large spaces, or for different metals.

Soft zinc, hard zinc, and copper all require different shaped tools because of the varied nature of the metals, and these shapes are shown at the ends of the tools, together with the size of the circle that the tool will cut. The bits are fastened into the head with a special chuck and are held very firmly, and without the slightest give or play. When dulled by wear they are ground on an emery wheel, a special handle being generally used for convenience of holding. Fig. 43 shows the shape of a bit for routing soft zinc, wood, and soft metals generally. Fig. 44 is a hard zinc router, and Fig. 45 is for copper. Special bits are better for the various metals. It is possible, in times of stress, to use them interchangeably, but it is considered bad practice, if it can possibly be avoided.

Routing machines, despite their fine construction, are easy to take care of, requiring little but regular oiling and cleaning, while the bushings, despite the speed at which they run, do not, as a rule, need to be replaced for several years.

Cutting apart. After the cuts on the flat etching are routed to the proper depth, the operator usually sets his machine to take a deeper cut, and goes entirely around the various engravings, cutting clear through the zinc, and separating each cut from the zinc around it. Any burr edge on the back of the cut is then removed with a file, and the plate is ready for blocking.



BEVELLING MACHINE
Fig. 46.

Beveling

The manipulation of a square finish half-tone cut is very different from that of a zinc etching, for the router is not used at all, the work being done on a machine called a "beveler," from the fact that it gives a beveled edge to the plate. Unlike a zinc etching, which is "tacked" to the block by nails driven through the metal at open spaces in the cut, the square finish half tone is tacked along the edge, because there are no open spaces in it large enough to allow a nail being driven through; the surface of the engraving is all covered with screen. The cut is first separated from the body of the flat, by sawing it loose, after which it is laid upon the bed of the beveler and located by means of an adjustable gauge, which gives the exact location of the cutting edge of the knives. It is possible to gauge the thickness of the black line, usually left upon a square finished half tone, almost to the one-hundredth part of an inch, and when the proper place is found, the plate is then held by a strong, reliable clamp. The head of a beveler is very similar to that of a trimmer, shown in Fig. 51, except that the knives are ground differently. There are usually three knives in a beveller head, one for channeling, and two for beveling. The former gives a depth below the surface of the engraving, and the latter bevels the metal on the outside of the cut. The plate is generally cut, on the saw, to leave about three-sixteenths of an inch, or a quarter of an inch outside of

the work, and the proper position being found by means of the gauge, it is clamped in place on a movable table, and passed under the revolving head, which cuts it in passing. The head, as in the trimmer, is usually covered with an adjustable shroud, as protection to the operator, and the table is moved either by a screw feed mechanism or by hand. The former gives a truer and more even motion, but the latter is much faster. There is also, on most machines a flue or hopper, into which the chips fly from the cutting knife, and which deposits them in a box on the floor. The beveler knives run about three thousand revolutions a minute, and the shape they make gives a good blocking surface along the edge of the half tone. A, Fig. 46, shows a beveled edge much enlarged, with a nail driven through it, holding the plate down to the block.

The Saw

The saw is a very necessary tool in every photo engraving house, for zinc, copper, wood, etc., have all to be cut to various sizes, and sometimes to accurate measurements. There are two or three types, such as pedestal, cabinet, etc., but the one shown in Fig. 47 is the most popular, and is used in the majority of houses. The first requirement is rigidity and stability, which, of course, implies a certain amount of weight, the average all metal saw weighing from five hundred to one thousand pounds. The table is usually ribbed, and has two gauges, one

of which is parallel with the saw, and shown on right of table, Fig. 47, the other is a gauge set at right angles to the saw, showing at left, and is sometimes called the push gauge, for a piece of wood, metal, or other substance can be laid against it, and the gauge pushed along the slot down in the table. This insures a right angled cut on the part of the saw.

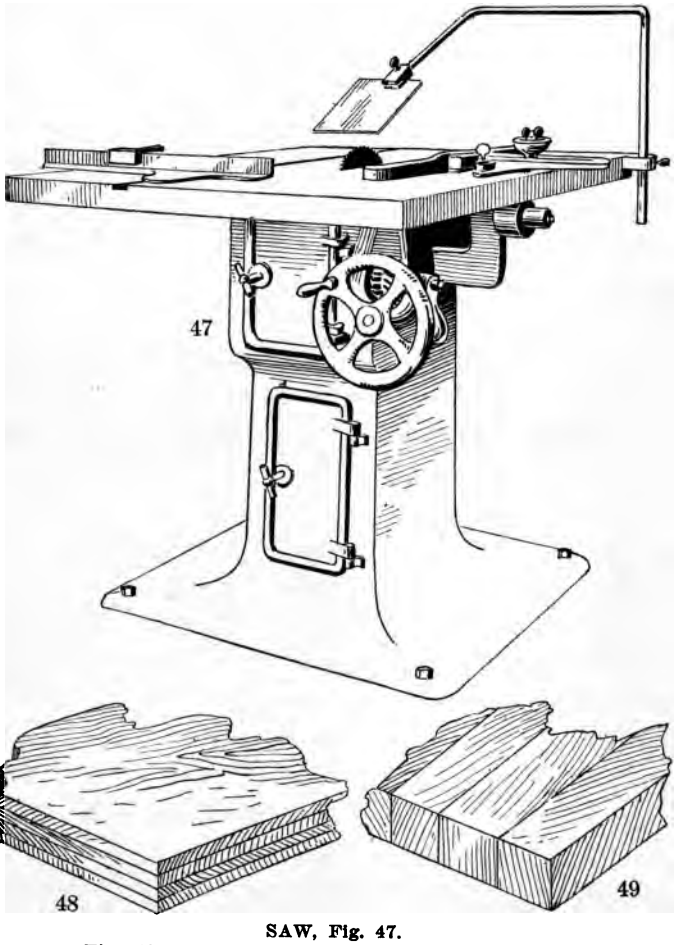
Different saws are used for wood and metal, and the mandrel of the saw, or shaft to which it is fastened, is one of the most important parts of the saw and should always be true and rigid. Ease in changing saws is quite an important feature, some providing doors in the pedestal, and so on; the most common device is to raise the saw table, generally by means of a screw and a hand wheel. It is very necessry that there should be some method of varying the size and depth of cut, and this is done by exposing more or less of the saw above the surface of the table. To accomplish this, some manufacturers make a tilting table, which rises at the front (as explained above), thus reducing the cut of the saw; other manufacturers make an adjustable mandrel, with a stationary table, through the slot of which the saw can be raised or lowered to the position desired. The long arm shown extended over the saw table holds a glass through which the operator can look at the saw cut, but which prevents flying metal striking the eyes. In operating a saw, there is one safety rule that should always be followed, and that is, while standing in front,

never reach behind the revolving saw to remove anything. This action has been the cause of many serious accidents.

Blocking

Character of Wood Used. Most engravings, whether zinc or copper, are blocked on wood to make them the standard height of type, and this wood must have special qualifications. It must be hard and solid; not warp readily, and be capable of being sawed, trimmed and planed without splitting; it must not "check" or splinter; must be very tough, and the grain must not be coarse or rough to offer undue hindrance to the work, and it must hold a nail solidly and tightly. The ideal wood for blocking is mahogany, and much of it is used for this purpose; also cherry, which is probably next to mahogany in favor, birch, walnut, and other woods of a like nature.

The cut, if a zinc etching, is usually nailed to this block by half-inch brads, driven through any open low space on it, and set down close to the metal, though care must always be exercised that they are not punched down too hard, or it may pull down the surface of the plate. In case the cut is solid and there are no open low spaces, then the edge is beveled on a beveler, Fig. 46, and the nails set into the sides of the metal. This is the method generally used in blocking half tones, which are nearly always solid faced cuts, and have to be fastened along the edges.



SAW, Fig. 47.
Fig. 48. Laminated Wood.—Fig. 49. Glued Wood.

Occasionally the cut must be made full size of the block, with no margin at all around the outside, making it impossible to nail even on a bevel, in which case it is "anchored" by a hole being drilled through the wood, and hot metal poured through this hole into contact with the back of the plate, which is thus soldered solidly to it. This is sometimes done with large size cuts which are solid, and where it is doubtful if the nails along the edge will hold the center of the plate solidly to the block against the suction of the printing roller.

Kinds of Blocking Wood. Blocking wood can be bought in various forms, either as plain boards or laminated, as Fig. 48, or glued, Fig. 49. Plain boards, bought at a lumber yard, are generally purchased in short lengths, because of the cheaper price, and of various widths from a few inches up. To use wood of this character it is necessary that there should be a planer in the blocking room, to smooth over the surface to be blocked upon, and also to finally plane down the thickness to the standard type height, so that it may be locked into a chase with type or other cuts. All shops do not have a planer, because it is possible to buy wood already shaved to the requisite thickness, so that the blocked cut will be just the proper height when the metal is fastened upon the wood. Many small shops do this, as it saves trouble and investment in an expensive machine.

Fig. 48 shows a type of (blocking) lumber that is quite good for blocking purposes; it can be bought in

any thickness, and is laminated and glued, being thin pieces in which the grain runs in opposite directions so as to prevent warping and twisting.

Fig. 49 shows a style of blocking wood made up of narrow pieces, the sides of which are planed smooth and true, and then glued together in a solid piece of any size. This style of blocking wood is quite satisfactory, and can be made in any size or width desired.

Blocking on Metal. Sometimes a cut is required to be blocked on metal instead of wood, and this can be done either with tacks, as when wood is used, or soldered solidly to the surface of the metal base. The last is for many reasons the best, as it makes one solid metal block of cut and base, but requires much more work and time, and, for the ordinary run of work, a cut that is tacked upon metal is quite satisfactory, for the metal holds the nails very tightly and securely, and there is little fear of the cut pulling loose. A shorter nail is generally used than when the engraving is blocked upon wood.

Trimming

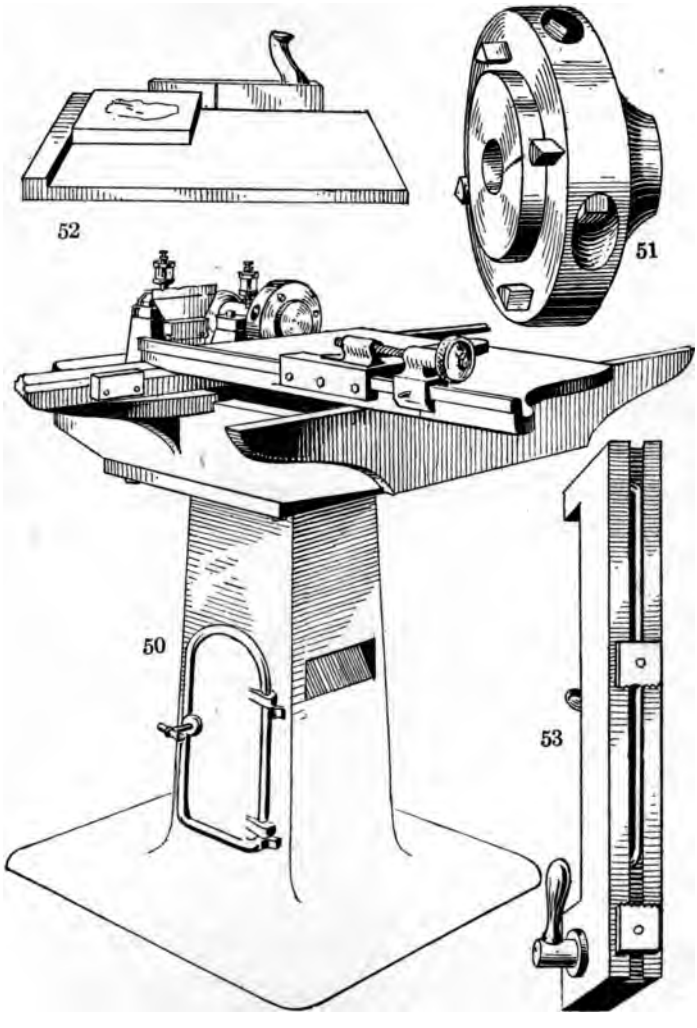
One of the essentials of all type forms is that the printing surface shall be true and flat, when it goes on to the bed of the press. Because of this it follows that each unit of the form, whether cut or type, must have perfectly flat sides, so that they will all lie close up together. When the chase is locked, and the quoins are tight, the

whole chase should be practically one solid piece; each side of each unit must set tight and flat against the adjacent side of the unit next to it, or the upper or printing surface will not be flat. If this is not done, or if the edges of a cut are not absolutely true and vertical when laid upon the imposing stone, the whole of the form would be set off of its "feet," and cause a lot of trouble and wasted time.

The Shoot Plane. When a cut is blocked it is usually one of a series (unless it is a large one), that are blocked with it upon one piece of wood. After blocking, these different cuts are separated by the saw, and then the blocker has, maybe, a couple of dozen different engravings, all with one-sixteenth to one-half on an inch of superfluous wood on each side. This wood must be removed, the cut reduced to the size required and the edges of the wood smoothed and trued up so that the cut will fit into its place on the type form. This work can be done on a shoot plane (though the trimmer is the machine generally used), Fig. 52, where the cut is laid with one side up against a projecting rib that runs crossways of the bed, and which sets at absolute right angles to the face of the plane. The bed of the machine is iron, with the projecting rib to place the cut against, and a sunken grooved way, at right angles to the rib, in which the plane fits and moves. When the cut is laid on the bed, it is pressed against the face of the plane, and the latter is moved backward and forward in the groove,

taking slight shavings off at each movement. It is, however, a slow process, particularly if there is much extra wood to be eliminated, and is seldom used for this purpose. Most shops have one, however, to take a thin shaving or so on off of a plate or block. The plane differs from an ordinary plane in the fact that the handle sets at right angles to the blade.

The trimmer, Fig. 50, is a much more efficient machine, and consists, roughly speaking, of a solid immovable pedestal with two tracks; and two movable parts, the head, including spindles, bearings, etc., and a bed. The head of the trimmer, Fig. 51, revolves and carries four knives, which revolve with it, hitting the block, and do the actual work of eliminating the superfluous wood from the edge of the engraving. This machine is generally geared to a speed of about four thousand revolutions a minute. The head is covered with a shroud, that protects the operator and at the same time deflects all chips and shavings to a chute leading towards the floor. The bed shown in the engraving at B slides backward and forward on the two tracks that are part of the pedestal. The hand wheel is fastened to a screw foot which operates a gauge, very similar to that shown upon the saw table, the cut is placed against this gauge and also against the rib or rail at the front side of the bed. After the block is in place it is held down with one hand, and the bed is slid along on the track carrying the cut with it; as the latter passes the trimmer head, the knives take



TRIMMING EQUIPMENT

Fig. 50. Trimmer.—Fig. 51. Trimmer Head.—Fig. 52. Shoot Plane.—Fig. 53. Line Holder.

off a shaving whose depth depends upon how far the cut is pushed out under the knives. The bed is then drawn back and the hand wheel is given a slight turn, which pushes the gauge over a trifle in the direction of the head, carrying the cut with it. The bed is then moved once more toward the rear, carrying the block again past the head of the trimmer, which takes off some more of the wood, and this operation is repeated until the edge of the block is trimmed down to the required size. This operation is performed for each side.

The Lineholder. Occasionally a cut has to be trimmed that is so thin it could not be held in the hand without danger of cutting the fingers on the knives. A lineholder, Fig. 53, is used to hold these thin engravings, so that they can be trimmed. The engraving is laid against the side of the line holder, where it is held firmly in place by an ingenious spring device, and the latter is then laid against the gauge with the engraving toward the trimmer head and passed backward and forward, as in the case of a big block. When trimmed enough, the sides are reversed and the other edge is trimmed.

The Jig Saw

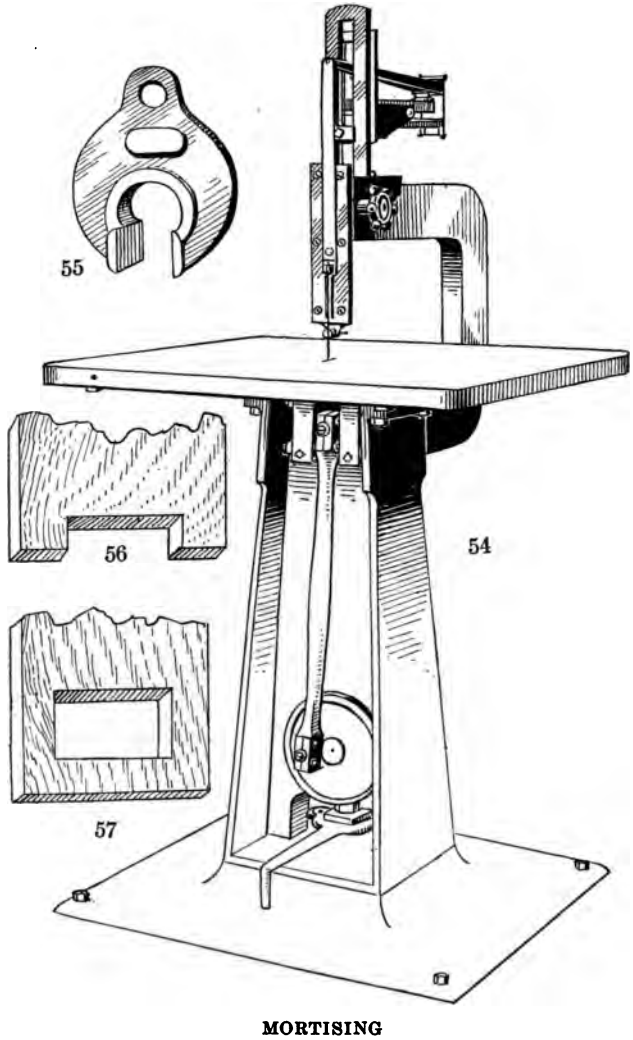
The main use of the jig saw is for making mortises, and a good type is shown in Fig. 54. The mechanical principle upon which it operates is readily seen in the engraving. The driving force comes from the rear of

the pedestal, whether delivered by a line shaft or individual motor, and is transmitted through to the wheel showing in front at bottom. From this a pitman shaft runs an attachment in a vertical slide, into which the lower part of the saw blade is fixed. The blade runs up through a slot in the table and is fastened above; the whole device working with an up and down motion when the power is thrown on. Many jig saws have a drill attachment so that all the actions required for mortising may be done on the one machine.

Mortises. Fig. 56 shows an outside mortise. This is practically all jig saw work, the two side cuts being made first, and the cross cut later.

Fig. 57 is an inside mortise. The best method of procedure in making it is to drill a hole close to one corner, remove the jig saw blade, place the engraving on the jig saw table, then replace the blade, passing it through the drill hole at the same time. Saw out the mortise and remove the engraving by loosening the saw blade. In either style of mortise the edges, if not quite true, can be finished off with a file, and the corners can be sharpened and squared up with one.

Type High. Fig. 55 is called a "type high." It is a gauge made especially for telling whether a cut is too high or too low. The engraving is simply passed through the opening between the jaws, and if it fits snugly, then the height is correct; if too loose, it is not high enough, which is often corrected by placing a thin cardboard



MORTISING

Fig. 54. Jig Saw.—Fig. 55. Type High.—Fig. 56. Outside Mortise.—Fig. 57. Inside Mortise.

between the plate and the wood; if it will not go in, it is too high.

Practically all of these machines can be bought in combinations, such as saw and trimmer, jig saw and drill, etc., but in the ordinary shop they are generally run as separate machines, and are used as described, excepting that special machinery may be added, if there is a certain grade of work in that locality; or extra machines may be used in a large shop, such as, for example, a planer.

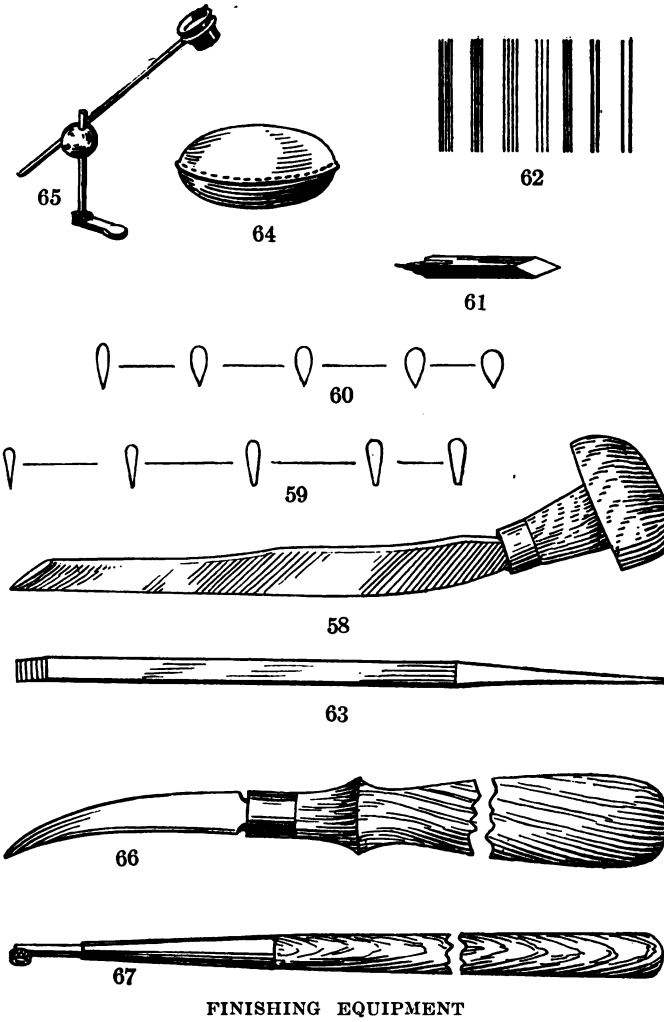
Finishing

The finisher is a very important part of the photo engraving oragnization, and the most specialized of any of the workmen. His craft depends almost exclusively on the skill of his hand, and this is only obtainable by long and continuous practice. The rest of the workmen are, to a large extent, interchangeable, that is, a photographer can nearly always print, probably etch, and *vice versa,* but a finisher, speaking generally, is a finisher only, unless he runs the proof press also, which, in most of the smaller shops he does. His work consists of looking over the engravings after the rest of the force have finished with them, and eliminating all imperfections, tooling away "spottings" in half tones, or thinning down touched-up lines in zinc etchings; cross hatching with white lines, blending edges, tooling "vignettes" or "cut-outs," cutting away superfluous dots, or "raising" the copper and replacing those etched away, putting a white

line along the black border of square finished half tones, tooling backgrounds, stippling detail in spots that have come too dark, or, in fact, doing anything possible to improve the engraving. Practically every plate is, and all should be looked over thoroughly and carefully by the finisher before it is proved and delivered to the customer.

Square Finish. Roughly speaking, there are three ways to finish a half-tone plate—square finish, Fig. 82, cut out, Fig. 83, and vignette, Fig. 84. Of these the square finish is by far the most popular, the cheapest and the quickest to produce. When a half-tone negative is cut to size it is naturally cut square, and the print from this forms the basis of the square finish, which simply consists of the laying of the plate upon the beveling machine, and the passing of the plate through it. After the plate is sawed loose from the flat, and laid upon the bed of the machine, the guide is used to regulate the size and also the thickness of the black line, if one is required. The white line is added by the finisher, either with an ordinary graver, such as is shown in Fig. 58, or with a special draw tool.

Cutout. A "cutout" is exactly what the name signifies, viz., an object cut out of the background; as a matter of fact, there is no background in a cut out, it is all tooled out and routed away. The outline of the object is carefully followed with a graver, and then the cut is treated exactly as a line engraving would be, the



FINISHING EQUIPMENT

Fig. 58. Side View of Graver.—Fig. 59. Straight Tint Tools.—Fig. 60. Elliptical Tint Tools.—Fig. 61. Lozenge.—Fig. 62. Liners.—Fig. 63. Chisel.—Fig. 64. Pad.—Fig. 65. Glass Holder.—Fig. 66. Burnisher.—Fig. 67. Roulette Wheel.

parts not wanted being routed away, leaving only the part of the cut that forms the object standing in bold relief against a white background. After the plate is routed, the edges of all the routed parts have to be tooled over and smoothed down with a chisel, Fig. 63, which removed all burr edges or any little points of copper that may have been turned up by the router bit.

Vignette. A vignette is very similar in treatment to a cut out, except that the edges are softened off to blend into the paper when printed instead of being cut sharp and standing out as a positive edge. The general shape is outlined by the graver, after which all metal outside of this is routed away. The treatment afterward depends somewhat upon the locality, the method in use, and the size of the shop. After being routed it sometimes goes back to the etcher, who will go around the edge with a brush full of iron, and re-etch the dots along it, making them smaller, so that the tint will be lighter and the edge fade away. Sometimes the finisher does this, and sometimes the dots are not etched at all, but the finisher takes a graver or a liner of the same coarseness as the screen and runs down the lines, pressing a little deeper and thinning the dots as he approaches the edges of the vignette. A vignetted cut is usually mounted upon the block with a little underlay below the center of the cut, which, bringing more pressure on the center, naturally makes the edges print lighter.

A sample approaching the work done by these liners,

but much coarser, is shown in Fig. 62. They are shaped like a regular tool, but the bottom edge is finished off with raised parallel lines, like those shown in Fig. 62, and they engrave these lines in the copper or other material on which they work. Liners are made in varying degrees of coarseness, and to fit the various sized screens, from fifty-line up. Because of this a finisher can lay a one-fifty-liner on a one-fifty-line half-tone cut, and the raised lines will fit in between the dots of the screen, which the finisher can "run" along, and so readily remove any irregularities from the cut. They are a great saver of time and trouble.

Gravers. The usual graver, such as is shown in Fig. 59, cuts only one line at a time, and the size of this line is graduated, by the depth of the cut, which depth is governed by the pressure applied; the heavier the pressure, the deeper the cut made. Fig. 59 shows a series of ordinary tint tools looked at from in front, and gives the shape of its cutting point. This style is far the easiest shape for a beginner to use, and makes a more even line than either the elliptical, Fig. 60, or the lozenge, or square tool, Fig. 61. In the hands of an expert, however, these last are much the most effective, because of the ease with which the line can be graduated, a slight pressure making a great difference in it. It is this great ease of graduation, however, that makes these tools so difficult for a beginner to use, as it is almost impossible for one not an expert to cut with an exact even pressure.

As it is exact even pressure that makes a smooth line, a lozenge tool in the hands of a tyro is apt to make a line of varied thicknesses.

One of the essential tools of the finisher is an engraver's pad, Fig. 64, which is simply a shaped bag of heavy leather, filled with sand or other heavy substance. The engraver lays the block to be cut upon this pad, face up, and twists and turns it in any way that may be convenient for him. In tooling, the handle of the graver is taken into the hollow of the hands, the fingers are placed on one side of the blade, and the thumb upon the other, the latter being used as a guide to the tool, which is pushed backward and forward along it by the action of the fingers. The cut is made on the forward movement, the point being sunk into the plate, and then pushed forward.

Most finishers use a magnifying glass, as in many cases it would be impossible to see their work with the naked eye. It is very evident that it would be far from feasible to attempt to follow the dots in a one-hundred-and-fifty-line to the inch half tone without the aid of some magnifying glass. Fig. 65 shows a typical glass and stand outfit. Most engravers use a stand of some adjustable type, which enables them to focus the glass at the exact point that best suits them.

Fig. 66 is a burnisher, a tool that is used for deepening the tone of any part of a cut that may show too light. This is done by rubbing down, or burnishing the top of

the dots, making them heavier, and so darkening the tone of the part burnished.

Fig. 67 is a roulette. The little wheel at the end turns on an axle, and is used for making stipples, lines, etc., on the plate according to the pattern cut in it. In case a part of the cut is too dark, say solid black instead of a tint, a stipple wheel will be fastened into the roulette, and run along the spot in the cut where it will make a series of little white dots in imitation of the dots that would be made by a half-tone screen. They are very handy little tools and great time savers.

Proving

Proving is the final operation in cut making, and a proof is always given to the customer to show him just what the cut really looks like. It generally shows very much better on the proof than when prined on a press, for several reasons, viz., it is printed by hand, and the pressure is regulated to fit that particular engraving; it is printed by itself, and so extraneous matter, such as type, need not be considered; the ink is better and heavier than can be used on a power press, and the paper is usually of a better quality than can be afforded in long runs for a book or catalog.

The Proof Press. While there are various styles of proof presses—self-inking, power, automatic feed, etc.—the most popular and the one that does the best work is the old-fashioned Washington hand press, that is really

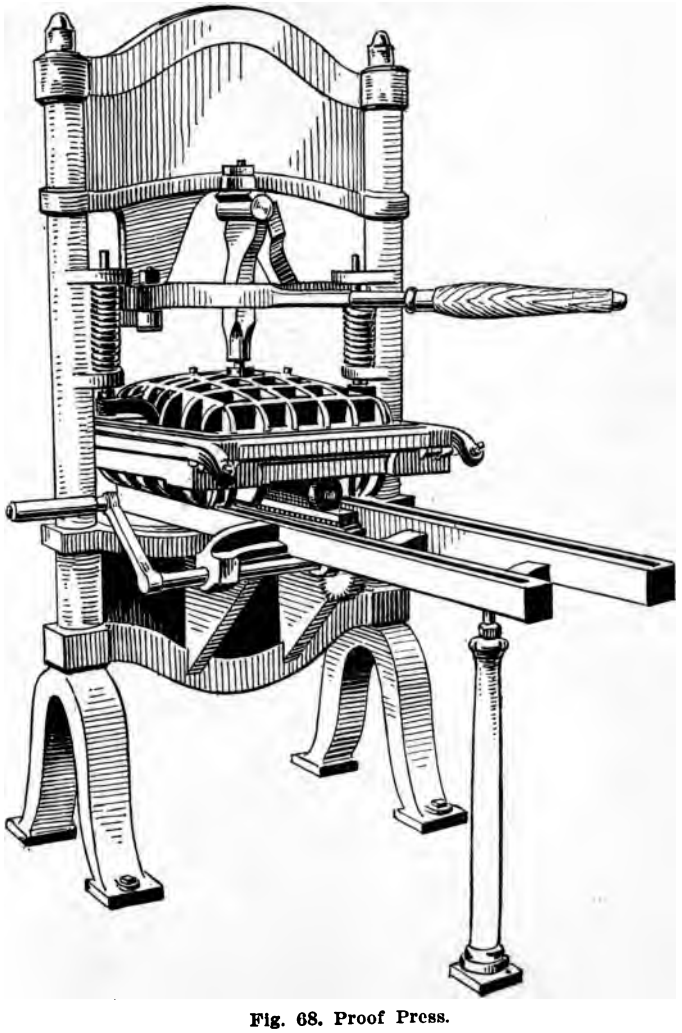


Fig. 68. Proof Press.

a modification of and improved form of the original hand press of the fifteenth century. In this style of press the upper platen is stationary, except for vertical movement, while the bed travels in and out, being moved by a belt or a rack and pinion, worked by the handle that shows in the front of the press. The bed of the press travels in and out on the two bars shown in the foreground. The cut is placed upon this bed, after being rolled up with ink, a bearer is placed on each side of it to keep the paper from sagging, the bed is run under the upper platen, the large handle at top is pulled over, which pulls the platen down on to the paper, and this pressure transfers the ink from the cut to the paper and makes the proof. Fig. 68 shows a proof press with the bed rolled underneath the platen. The bed and platen must be in perfect alignment, and come together with a flat uniform impression over the whole bed. It is this flat impression that gives such a perfect proof, and makes work done upon a hand press superior in quality to any that it is possible to obtain by other means.

Cuts are inked up for proving by a composition hand roller, with either one or two handles, like Fig. 29, the ink being first rolled out on a slab. It should be distributed perfectly on this slab before being transferred to the cut.

The ink used is made especially for proving purposes and can be bought in small quantities. There are many excellent brands upon the market. As stated before, the

proof is the final operation in the manufacture of a plate, and its acceptance by the customer is a sign of satisfaction with the work.

Line cuts are generally proved on a fair or good quality of book paper, but half tones are generally proved on a high grade of coated stock or enamel. This paper is generally quite heavy, with a fine surface, and is often specially made for this purpose. It is not a good plan to attempt to prove a fine half-tone cut on cheap or inferior paper, for it will certainly make a bad impression on the customer.

CHAPTER 4

THE WORKING OF THE PROCESS

1. *Summary*

The Two Processes. As the reader will understand by this time, photo engraving divides itself naturally into two processes, zinc etching and half tone, and while the manipulations are the same in some ways, yet, speaking generally, the processes are entirely separate. The half tone will reproduce practically anything; diversity of tones is no obstacle, and it will engrave a quarter tone, or three-quarter tone as readily and effectively as a half tone or a black. Zinc etching, on the contrary, reproduces black and white copy exclusively. Pen drawings, line illustrations, or anything where the thing to be reproduced is solid black, are line etching subjects. The page of the book upon which these words are printed, for example, would readily reproduce in line etching, because the type is solid black and the paper white. Wash drawings, oil paintings, photographs, or other copy in which the tones vary, are not subjects for zinc etching and should be reproduced by half tone.

Speaking generally once more, there are two kinds of

copy—one in which the tones are drawn directly upon the paper in a solid dead black, and the mixture of this dead black and the white paper makes different tones according to the varying amount of white paper and black ink that is used; pen drawings, wood engravings, etc., fall into this class. The mass of the type on this page, held a little distance away, takes on a slightly gray tone, due to the mixture of black ink and white paper. In the other kind of copy, the varying tones of black and white required are mixed before being placed upon the paper, and show, when on the paper, absolute reproductions of the strength of those tones. This latter type of copy is reproduced by the half-tone process, the former by line etching.

Another problem is introduced by the limitations of the printing press, which can only use an ink of one strength, say black, and not of varying tones and gradations. Because of this limitation it becomes apparent that the only manner in which it is possible to print an intermediate tone is by mixing this black ink with the white paper in such proportions as will obtain the particular tone desired. This is the object of the screen in the camera, the combination of which with the lens and copy, mechanically splits the varying solid tones of the copy into dots and lines capable of being printed in black ink, which simulate the strength of tone desired. That is, the solid tones of the copy are duplicated by mixtures of black and white upon the printed page.

Speaking generally, half tones are etched on copper and line cuts on zinc, though occasionally very fine line work is done on copper and some classes of half-tone work upon zinc.

Of the two processes, line etching, or as it is generally called in the trade, zinc etching, is by far the simplest, largely because the coarser character of the work admits of rougher manipulation. Both processes begin with the photographer, and end with the finisher, but the intermediate steps are very dissimilar.

At the present time practically all illustrations printed with the text are made by photo engraving, wood engraving being seldom seen any more, except for special work or printing. Photo engraving is, as a rule, so much lower in price, quicker to make, and, also, unless for long runs or because there is a wish to save the original, it eliminates the necessity of an electrotype.

The first step in both processes is the negative, and because it is the simplest, an explanation of zinc etching will be given first. While both line and half tone begin with the negative, the intervening steps are many and must be followed carefully, for each has much effect upon the final result.

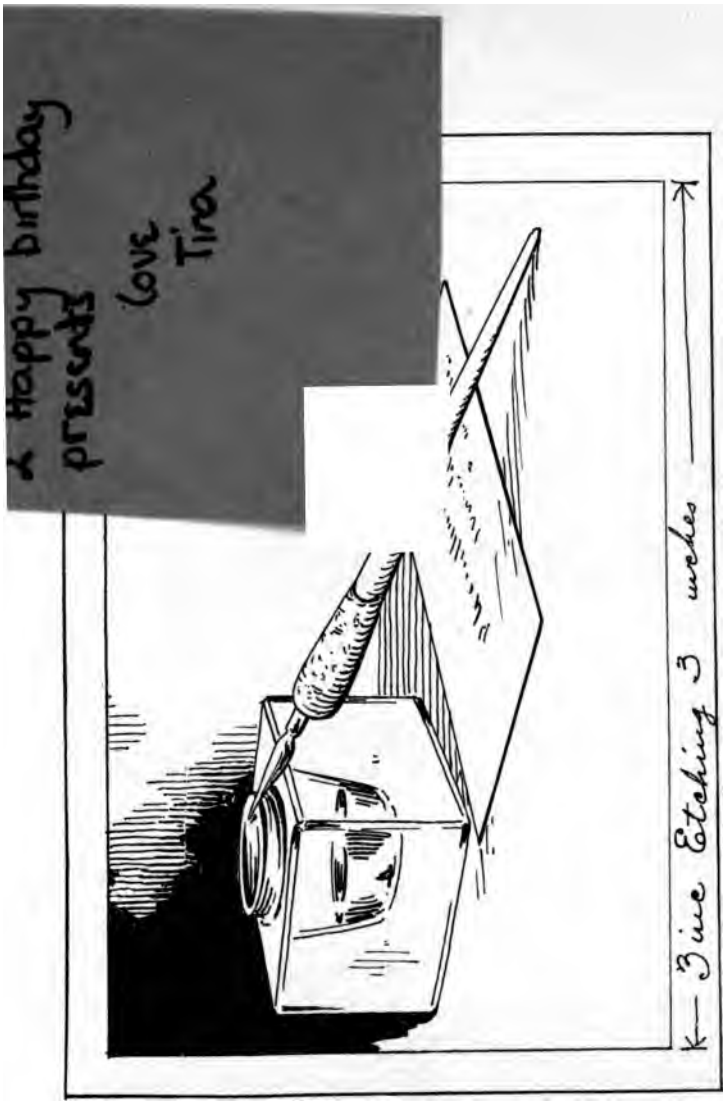
2. *The Manufacture of a Line Engraving.*

Fig. 69 shows a pen and ink drawing, marked up for size, etc., in the manner usual with copy. A zinc etching is to be made of it, three and one-half inches wide. The

photographer receives it in the form the figure shows, usually with a shop ticket attached, on which certain details are written.

Flowing the Plate. Taking down one of his smaller pieces of albumenized glass, he carefully dusts it with a camel's hair brush, and laying the uncoated side upon his outspread fingers, flows it with collodion, starting at the upper left-hand corner. Plenty is poured on, then the plate tilted so that the residue runs off at the lower right-hand corner, back into the bottle, which is corked at once and laid away. The collodionized plate is waved gently back and forward in the air to dry the surface by the evaporation of the ether and alcohol, and as soon as it becomes "tacky" it is put upon the dipper and immersed in the silver bath. The lower part of the collodion should be dry enough to tear, and, under no circumstances must the operator let the collodion run back on the plate or there will be uneven streaks on the finished negative, due to different thickness in the collodion.

While the plate is being coated in the bath, the photographer tacks up the copy and focuses it, being sure the size is correct, and that the lines are sharp, for which purpose most photographers use a focusing glass, Fig. 25. By the time this is done, the four minutes that the collodionized plate should be in the bath is up, and the door of the dark room is shut, plate holder lifted, and, after draining the plate long enough to let the loose silver run back into the bath, the plate is shut into the



FACSIMILE OF PEN DRAWING
Fig. 69.

plate holder, the latter placed in the camera, the lights turned on, slide pulled out, cap taken off lens, and exposure made.

Exposure. The length of time necessary for exposure varies with the lens, lights, character of copy, size of stop, etc., but the average is probably in the neighborhood of one-half minute. When this is finished, the cap is put back, the plate holder slide pushed in, the plate holder itself removed from the camera and taken into the dark room. Until the plate is fixed, the door should stay shut.

Developing. To remove the plate from holder, place the latter upon a shelf, with the slide turned away from you, and open the door in back. Be careful about marking up the sensitive side of the plate with the fingers. Take the plate over to the sink and start the water running, then resting it upon the outspread fingers of the left hand, pour plenty of developer over it, so that there will be no halt or delay in the liquid spreading, and all portions of the plate will be covered as nearly instantaneously as possible. If the plate is a large one, it is customary to run the bottle along the edge of the plate, allowing the developer to flow freely over all of it. The longer the exposure the heavier a film may be developed, but the more chance there is of fogging detail; the longer the plate is developed the heavier the film will be, but the chance of fogging detail is the same. Other things being equal, the effect of a long exposure or a long

developer is the same. If the time of the exposure is correct, the image will gradually appear upon the plate, and should be stopped as soon as the detail is all up. When satisfied that all detail is showing and that the image appears to be developed enough, slip under water faucet (which should be running at the time), and wash well.

Fixing. Fix by pouring the solution of cyanide of potassium over it, which will dissolve and cut away all portions of the picture that have not been acted upon by the light, and wash again. The image now shows as clear glass upon a background of thin transparent film, and the copy is permanently fixed upon the glass, but is of no material use in its present shape, because of its thinness and transparency. It must be made thicker and heavier, the film portion must be made solid and opaque (at the same time that the lines stay clear glass) before it will be in fit condition to print upon the metal. This is accomplished by intensification.

Intensifying. After washing the cyanide well off, lay the plate face upward in the bleaching bath of copper, and allow it to remain there until the film takes on a dirty white look, then remove and wash carefully once more. Blacken with the solution of silver, wash carefully and examine with a glass to see that all lines are good and sharp. When held up to the light, the probability is that the film will be solid and opaque, but that the lines will be a trifle "fogged," that is, covered with a thin,

milky looking film—and the glass, that should be quite transparent, will not be absolutely so.

Cutting. Flow the negative with a solution of iodine dissolved in water which will turn the film to a yellow looking color and thicken it greatly; at the same time it will deposit upon the lines that should be clear glass, making them more cloudy than ever. Pour a little of the dissolved cyanide, say one-half ounce, into a graduate, add about ten ounces of water, and flow across the negative. The strength of this solution must be judged by its action. If too strong, it will cut too rapidly, and also "chew" the part of the film that should remain solid, eating it away and making it transparent; if too weak, it will have little or no effect of any kind; if the strength is just correct it will cut away the scum and the fog from the lines and leave them clear glass, without affecting the body of the film. At the same time, care must be used that it does not spread the lines sideways and make them too thick, which it is apt to do if left on the plate too long. The instant the glass is clear, slide the negative under the water faucet and wash off all the cyanide. If, after another examination with the magnifying glass, the lines show clear, intensify again and the negative is finished.

Some operators prefer to mix cyanide and iodine together, using them as one solution instead of separately, claiming that the iodine builds up the body of the film the while the cyanide is cutting the lines. This

is all a matter of choice, however, so the operator must decide for himself; good work is done under either system, and there is really little difference in the final result, which, of course, is what is to be considered.

Most photographers clear the edges of the glass of film, so that a finished negative, when held up to the light, looks like Fig. 70, where the black is the film, and the white part absolutely clear glass. When in this condition the work of the photographer is finished, and the negative is placed in the rack ready for the stripper, who will add it to a flat, and then pass it on to the printer and etcher.

If the job is in no hurry, and taking the regular course, can wait its turn with other cuts, it is allowed to dry naturally in the rack; if it is in a hurry, however, and must be pushed through, it can be dried by heat, always taking care that the glass is never made warm enough to crack, and, if it is dried by heat, the glass must cool off before applying rubber.

Flowing the dried negative with rubber is the next operation, which (and this applies to practically all flowing of glass or plates except in developing, where the developer must be allowed to run off into the sink) is poured on the upper left-hand corner, and run off, back into the bottle, at the lower right. Rubber cannot be dried by heat, or it will bubble and pinhole and spoil the film. A gentle blowing is about all that can be used

to hasten it. Because of the high volatility of gasoline, this operation wil' not take long, under any circumstances, and the tine can usually be spent flowing other plates.

When the rubber is dry, flow the leather collodion over it, and, if cut is in a hurry, this can be set afire without harming the film, which is the quickest way to dry the solution. Do not let glass get so hot that it will crack. As soon as this is dry cut the negative with a sharp knife, so it can be easily removed from the glass, and lay for a few moments in the acetic acid solution to dissolve the albumen. It is now ready to be made into a flat.

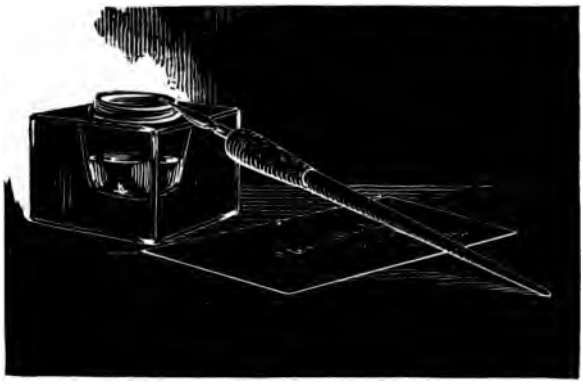
Making up a Flat. In making up a flat, always have water on the glass so that the film can be moved backward and forward to the place where it is needed. As soon as the film is located, squeeze out the water from underneath by means of a square of blotting paper, being careful not to tear or "slug" the negative, and it will hold fast to the plate. The film, after the collodion dries, is quite tough and leathery, and the usual way to strip it is to lift one corner with the point of a sharp knife. Slip the blade below the film, place the thumb on top and turn it over on to the glass. After all the negatives are on, most "strippers" place a sheet of damp paper over the flat, and run a squeegee over it for the purpose of taking up any loose water on the glass. The

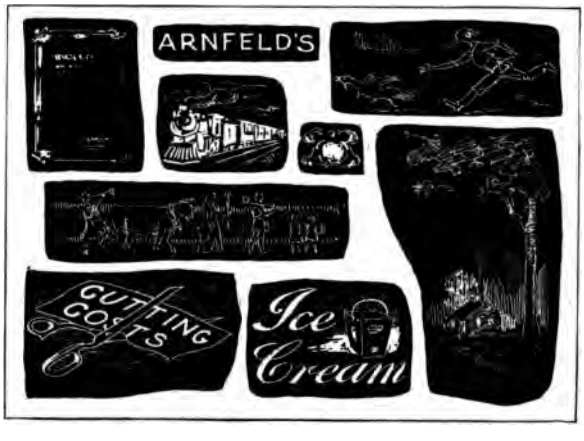
flat must dry naturally or with only very gentle heat, for if too much heat is applied the films will curl and fall off.

A flat when made and dry, is then ready for the printer, and when held to the light should look about as Fig. 71, though, of course, this is reduced to conform to the size of the page, and no effort has been made to show the work on the individual negatives. Each negative will be a separate cut when the various operations are finished.

The printer has his sheet of zinc all ready cut and polished, and goes over the surface thoroughly with some powdered chalk or fine pumice to take away all grease or finger marks, and also carefully files away any burr edges from the saw cut. It is now ready for the sensitizing solution. Sensitizing solution prints much faster when thin and slower when thick, due to the fact that the light has further to penetrate into a thick solution.

Sensitizing the Zinc Plate. To coat with sensitizer, hold the zinc plate under the water faucet, so that there is a thin film of water on it, then lay the back of the plate on the outstretched fingers of the left hand, so that there will be no finger marks upon the front, and with one end, usually the near right corner, depressed. Pour some of the printing solution on the top left corner and let it flow down, driving the water before it and off into the sink. Be sure that the solution covers the plate





LINE NEGATIVES

Fig. 70. Negative of Fig. 69.—Fig. 71. Flat of Line Negatives.

completely, leaving no places where there is simply water. After draining, repeat, but run the solution down to the lower right corner and into the bottle. Do this three or four times, being sure to keep the angle of the plate the same, and being especially careful that the solution does not flow back. If it should do so it is almost certain that the plate will be spoiled, for the solution will be heavier in some places than in others, and the print, when made, will not be even but streaky, because of the difference in the thickness of the coating. When satisfied that there is enough solution on the plate, dry by gentle heat and gentle blowing from the top downward, being sure to hold the plate at the same angle. Neither the heat nor the blowing must be strong, for one will destroy the sensitiveness and the other will make the sensitizer run in ridges. No dark room is necessary for this operation, for while the solution is sensitive as soon as dry, yet this sensitiveness is low, and as long as no direct strong light falls upon the plate it will not fog or spoil. The operation of coating the plate is usually performed in a little walled-in corner or closet, with a gas stove and sink in it. If the sun shines in, pull down a blind.

When the plate is dry, it is customary to set it on one side for a moment to cool, while the printer gets the frame, Fig. 32, and negative flat ready for it.

Wipe the glass of the frame clean, and see that there is no dirt or any such substance inside it, for foreign

matter will not only interfere with the print, making a bad spot on it, but may even crack both glasses, when the pressure is applied. When satisfied that the glass is clean, and the zinc cool, lay the zinc plate on a slab, sensitized side up, and the negative flat upon it, films down, so that the negative films are in direct contact with the sensitive side of the zinc. Then lift both by placing a hand on two opposite sides, and turn over, so that the zinc is uppermost, and the negative flat below, and place in the frame. This is a delicate operation, and care must be taken that the flat does not slip around on the zinc plate, or the negative will be scratched or torn. When the flat and zinc are in the frame lay several sheets of cardboard over them, place the back of the frame in place, and clamp down the holding bars on to the top of the back. Absolute contact must be obtained between the zinc and the negative, or the print will be weak, and the lines thick and fuzzy. Examine carefully from the front of frame, where it is usually possible to tell whether contact is obtained, or not. Some printers look for a certain rainbow effect behind the heavy plate glass that shows when the contact is strong and perfect.

Printing. Expose for the length of time necessary, and this is impossible to give, because the exposure depends absolutely on two things, viz., the strength of the light used, and the speed of the sensitizing solution. The exposure must be long enough, however, to firmly set the exposed lines, so that they will not rub away in

developing, yet not long enough to thicken the lines, or give the light any chance to force its way through the solid parts of the negative. Usually it takes about five minutes, during which time the printer is doing some other thing, or making ready for the next print.

Developing the Print. When the exposure is completed, shut off the lights, open the frame, and take out the zinc, being careful not to scratch or "slug" the negative; lay the sheet of zinc, printed side up, on the rolling up slab, and ink thoroughly with the ink roller. Most printers do this from two or three sides. A fairly good quantity of ink is very needful on a print, so as to take a good "topping," and the solution, where it has been printed on through the light places in the negative, is also useful for an acid resist. When the zinc is fully covered, place in a pan with water, and let lie for a moment or two; then wet a piece of cotton large enough to have some weight, and draw over the print. If the time of exposure was correct, the unprinted part will come away, leaving the zinc clear, except for the printed lines, which will show black; if undertimed, lines and everything else are liable to rub away, or be "rotten," and a new print must be made; if slightly overtimed, a gentle rubbing with the cotton will sometimes clear it up, but do not scrub too hard, or it will smudge the ink. Most printers use an easy circular motion that is very effective. If this does not clear up the background, drop a few spots of aqua ammonia

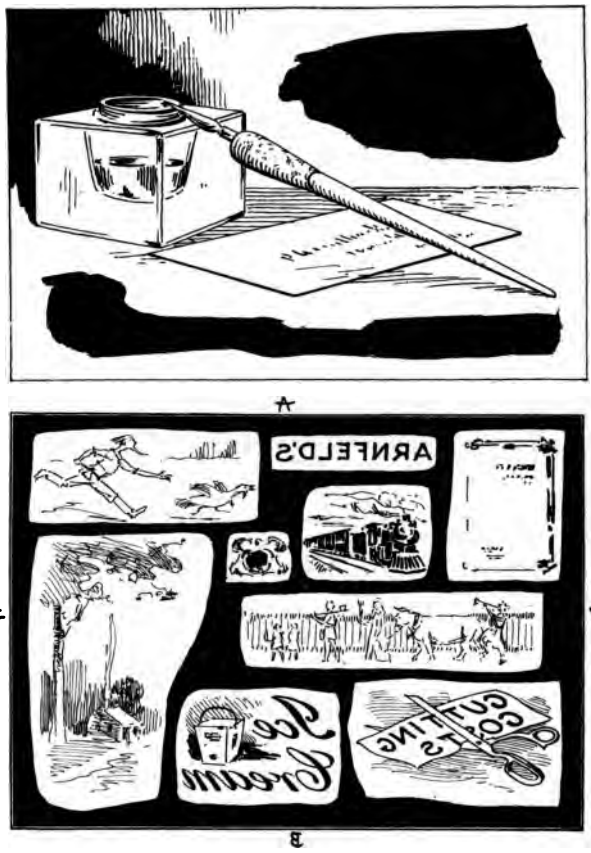
into the water, and if, after a gentle rubbing, the print does not then clear up, a new one must be made.

If the print develops up so that there is only polished clear zinc and strong sharp ink lines, it is ready for the zinc etcher, and can be dried and given to him for future work.

After the print is developed, examine carefully with a glass to be sure all detail is "up," particularly thin white lines, or white dots on black, and see that all black lines are solid. If all is correct, put into the rack for etching. A plate should not stand too long after printing before being "topped" or the ink will be apt to lose some of its acid resisting power; most etchers take the print and run it through the topping powder right away, and if it is not to be etched soon, leave it covered with powder, until they are ready to attend to it. Before etching, the etcher must go over it carefully with a fine brush and spot up any broken lines, etc., and also paint in all large open spaces, as in Fig. 72. This is so that the acid etching bath will have no more work to do than necessary.

This covering of all large open spaces on the zinc relieves the acid bath of much work, saves acid that would be used in etching, and also prevents the bath becoming "dirty" from excess of zinc etched into it.

Topping. When ready to etch, run the plate through the topping powder (which can be bought, as can dragon's blood, all ready for use). This is for the



LINE PRINTS

Fig. 72. Print of Fig. 69 with open spaces painted in.—Fig. 73. Print of Fig. 71 ready for topping.

purpose of covering the ink lines. Then stand the plate on one edge, giving a sharp rap or two on the edge of the drawer. Most of the powder will fall away from the unprinted zinc, yet not all, and this must be brushed carefully off with a soft camel's hair brush, or with a pledget of absorbent cotton, till the zinc shows perfectly clean, leaving only the ink print with the topping powder clinging to it. When the zinc is clear, lay it on the gas stove and melt the powder. This is a careful operation, for it must be melted till the powder is one solid piece, and loses its powdery qualities, and yet too much heat must not be applied, or the powder and ink will spread, making the lines much thicker than they should be, and filling up the detail. While still hot, stand up face to the wall, and paint the back with asphaltum; this is also to save the back of the plate from etching in the bath, which would dirty the latter, and likewise thin down the zinc too much, as a certain amount of the thickness would be evenly etched away from the back.

The First Bite. As soon as the back is painted, hold the plate beneath the water faucet to cool it off, allowing the water to run all over it, back and front, and place in the acid bath for the first "bite." The depth of this bite depends largely upon the character and fineness of the work upon the flat—a flat of coarse work will stand more and deeper etching than one where the cuts are of a fine character. There is no absolute way to measure,

however, most etchers testing with the thumb nail on an open piece of the zinc against a black edge, and likewise with the magnifying glass. When the nail catches firmly against the unetched zinc, it is apt to be ready to take out; but an examination with the glass may show that it will stand more etching, in which case it should be given, for a deep first etch is an excellent thing, as upon it depends the printing quality of the detail, much of which will fill up when powdering for the next bite. The first bite of a zinc etching should be all that the print will stand without destroying any of the detail or fine lines. Experience is the only thing that will tell when the bite has gone far enough, though the thumb nail test is as safe a rule to follow as any. During the etching the tub is rocked so that the acid flows back and forward over the plate, and the plate itself gradually becomes dirty looking from the deposition of dissolved zinc. This must be removed occasionally with a brush, so that the etcher can see the work clearly, though too much or too heavy brushing will weaken the top.

When satisfied that the work is deep enough, lift the plate from the bath, and rinse all the acid off of it under the water faucet, then swab it gently with a piece of chamois skin, and lay on the gas stove for a moment or two, to take away any of the cold dampness that may attach to it. Look it over carefully with the glass to see if the topping has gone off any of the lines or dots, or if there are any scratches on the top, for if there are,

they must be touched up with ink or asphaltum. The plate is then ready for "powdering."

Powdering. The object of powdering is to protect the sides of the lines from undercutting in the second and subsequent bites. The sides of a line on a good zinc etching should be perpendicular; if they slant inward they are undercut, and the top may break off; if they slant outward, it shows that the etcher has not allowed it to stay long enough in the acid to etch the "shoulder" away, or that he has powdered too heavily, or that he has melted the powder too much and it has run. Take the plate by one edge, and run it into the powder, raise it up and allow what will to fall off the plate, then brush (in the direction the powder fell), all the loose dragon's blood off of the plate. The powder will stick to the sides of the lines, which is the reason for powdering, as, when melted, it forms a protection from the acid. When bottom is clean, lay on gas stove and melt. Assuming Fig. 73 is the plate we have just powdered, and A is the edge we have powdered from, then all sides of lines facing toward A have a protection on them that will resist the acid. Cool the plate and turn around so that B takes the place of A and powder from this side and melt; do likewise with C and D. Now the plate has been powdered from each edge, the sides of all lines are protected against undercutting, and it is ready for the next bite.

This is simply a repetition of the first one, except that

the etch can be carried somewhat deeper, and there is a little more acid added to the bath, to replace that used in the first bite, and also because the plate will now stand a stronger bath and quicker work. When considered deep enough, take out of the bath and repeat the powdering.

Do the same the third time, and possibly the fourth. As a general rule, most etchings get four bites, though some may get five, and some only three. This is for the etcher to decide, his decision depending largely on the character of the work. After the last bite is given, some etchers give a cleaning up bite, that is, they wash all the topping and protection off of the plate, then ink it up again with a hard litho roller, Fig. 30, and powder the ink with dragon's blood, brushing it off of the side of the lines, however, after which they lay it for a few moments in the tub. If there is any "shoulder" to the lines, it will probably etch away, leaving the sides of the lines clear and clean.

When the etching is finished, the flat is heated and washed off with lye. The usual manner is to have a big crock filled with strong lye and to plunge the warm plate into it, though sometimes the lye is poured on from a pitcher or similar article. It is then scrubbed all over, front and back, with a stiff brush, Fig. 37, until every trace of powder or ink is removed. The plate is then inked up and a proof pulled, after which the router takes it to deepen the larger open spots. The depth of

a zinc etching varies greatly, but this etching is only for the purpose of etching down the detail to printing depth. Larger spaces can be routed out much more speedily than they can be etched, and a greater depth and better printing quality is also obtained.

The running of a router is not a difficult matter, though it takes much practice to attain speed, and after this is done, the plate is blocked, trimmed to size, and the finisher takes it for final work, such as spotting, etc., after which it is proved, Fig. 74, and delivered.

Half Tone Photography

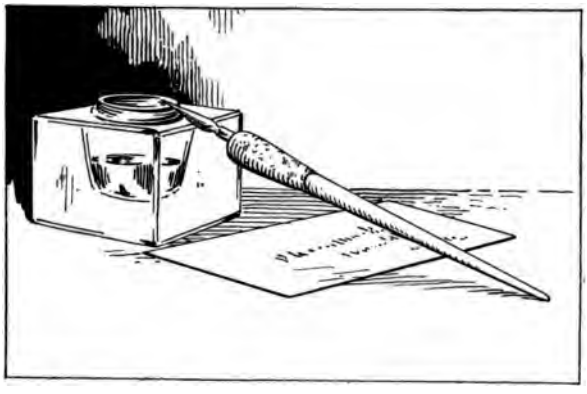
The photography of a half-tone copy differs in many ways from that of a pure black and white, largely because of the interposition of the screen between the sensitive plate and the lens. The distance between the screen and plate, or "separation," as it is generally called, varies greatly with the fineness of the screen, and the character of the work. Greater separation gives more contrast; less separation gives more detail. By manipulation of the screen and the stops, or diaphragms, it is possible to get much more contrast in a negative than in the copy. The average separation for a one hundred thirty-three line screen is probably around three-sixteenths of an inch.

Manipulations of the Stops. Diaphragms or "stops," as they are generally called, play a very large part in half-tone photography, more than one stop being gen-

erally used. It is possible to change the entire character of a cut by the manipulation of the stops, and one can turn a regular half-tone negative, photographed through an ordinary screen ruled both ways, into a cut where the lines run all in one direction, with no cross lining at all.

The fact that the operator can vary the tonal quality of the copy, can change the very character of it; can give it color, or flatness, or mass; can photograph or largely eliminate the detail; can vary the character of the lines that will finally compose the picture tones; can make of it a good, bad or indifferent cut, is one reason why he is a factor of such great importance in the final result. A slight change of method, on his part, may obtain a totally different looking negative from that which the copy would naturally make, and it is the ability to see the necessity of any change, and the skill to put it into action that goes very largely toward the making of a good or bad photographer. The simple reproduction of copy is one thing, the ability to seize the salient principles of that copy and to incorporate them into his negative is another, and is one sign of the good operator.

Stops come in various forms, from the iris diaphragms that are so common in hand cameras to certain patented ones that professional photographers use. The generally accepted form, however, are the "Waterhouse" stops or diaphragms, shaped on the order of Fig. 5, and which



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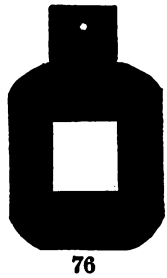

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STOPS, ETC.

Fig. 74. Finished cut of Fig. 69.—Fig. 75. Round Stop.—Fig. 76. Square Stop.—Fig. 77. Corner Stop.—Fig. 78. Double Corner Stop.—Fig. 79. Oval Stop.

are dropped into a slot in the barrel of the lens, situated between the two combinations of glass. Usually the holes in these stops are round, but many photographers use holes of various shapes, some of their own invention, some standard, either because they think these special stops do better work or to fit with some idea or theory of their own, or to get a different shaped dot in their negative.

Varieties of Stops. Fig. 75 is a regular round stop; Fig. 76 shows a regular square stop, which some operators prefer; Fig. 77 is used sometimes where a strong negative is wanted, and Fig. 78 is a variation that is often employed. Fig. 79 shows the shape of a stop that will give a one-direction line half tone, and eliminate all cross lines of black. These various stops can be made with press board or filed out of thin sheets of brass, etc. A beginner is advised to choose one kind of stop and keep to it, and the round one is as good as any. If an operator, before he is expert, begins experimenting with the various shapes of stops, he is very apt to get badly muddled in his work and draw many wrong conclusions of their value from the results he will obtain. As in other businesses, an expert workman can use anything.

After the copy is on the board and focused, the plate is set in the holder; and the holder in place on the back of the camera, the slide is pulled out, the cap taken off the lens, and the exposure made with a small stop, say one about as shown in Fig. 75, for two and one-half

minutes; then the cap is put on the lens, the first stop is taken out and another, somewhat larger, is put in its place, and an exposure made of possibly one and one-half minutes; again the stop is changed to, say Fig. 76, and an exposure of thirty seconds made, after which the cap is replaced on the lens, and a piece of white cardboard or paper is hung over the copy and another exposure is made of possibly ten seconds. This last exposure is known as "flashing," and is for the purpose of strengthening the white dots of the negative. The theory of changing the stops is that the small stop photographs the darker tones, the middle sized stop the medium ones, and the large stop the high lights. Certain it is that an exposure made with only one stop is very flat, and if the stop is small, the high lights will almost certainly be joined at the corners. (This will sometimes occur even with ordinary stops, and if these corners do not fill up when intensifying and give an unjoined dot in the high light, and they are carried joined to the etching, it will, almost surely, make a muddy looking cut.) If the exposure is made with one large stop, the general tone of the negative will be too "high," the darker parts showing much lighter than they should. A few exposures with only one stop, with and without flashing, will be well worth while to any beginner.

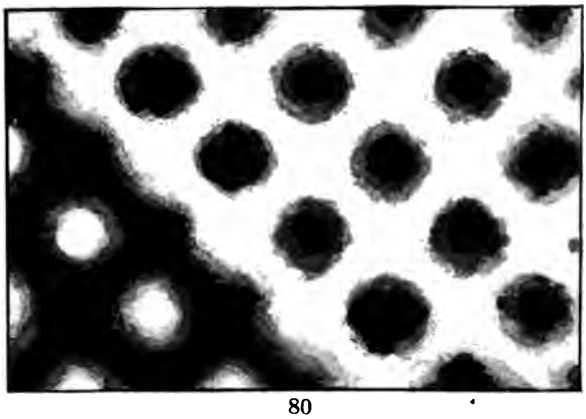
Developing and Clearing. The exposure made, the plate is taken into the dark room, developed, and intensified the same as a line negative. When this is done the

negative will look somewhat as in Fig. 80, that is, each individual dot, whether white or black, will have a "fuzzy" edge. (This figure is, of course, very much enlarged.) There will also, very likely, be a thin scum or film over the glass, and this and the "fuzz" must be removed, or the negative will not print cleanly or sharply. The method of manipulation is exactly the same as for line work, viz., cyanide and iodine, and the operation must be continued until the glass is absolutely clear and the dark parts become solid black. This may require much manipulation, and very careful manipulation at that, because not only must the glass be clear and the solid parts opaque, but the general tone of the picture must be preserved, for too much cutting will make it dark, while too much building up may make it too light. The latter is fairly easy to correct, as a high negative may be cut down somewhat with weak cyanide, but a negative that has been cut too far is almost impossible to "bring back," because the "fuzz," etc., on which to build has all been cut away. As a general rule, it is better to throw such a negative away, and make a new exposure.

Negative Requirements. It will be seen from the foregoing that there are two things that the half tone operator must watch—firstly, the clearness and printing quality of the dots and lines composing his negative, and, secondly, the color, quality and detail of his negative as a whole, and the manner in which it reproduces his

copy. Tonal quality must be reproduced, and the detail must be photographed correctly, and yet not brought out too strongly. In addition to these two requirements there is another just as imperative, viz., the etching quality of the negative. It is comparatively an easy matter to make a fine looking negative, one that will reproduce the copy accurately, bring all detail out in its proper proportions and tonal qualities, have clear glass and solid background, and yet be one from which no half-tone etcher could make a satisfactory printing plate. Hence it is necessary for the photographer to know the methods of etching and the requirements of the press.

Taking a one hundred thirty-three line screen as a standard, the necessary depth required for an etching is about 1-250th of an inch. This seems a small figure, yet is plenty for all requirements, for while the iron of the etching bath is eating downward, it is also eating sideways, the consequence being that it takes approximately as much off each side of each dot as it does off the exposed surface of the copper. (This is not exactly true, but near enough for our argument.) As the depth of a copper etching varies in hundredths of an inch, according to the fineness of ruling on the screen used, it would be both difficult and useless to detail each and every ruling, so, for the sake of clarity, we have taken the simple number of one inch, which, while impossible, will make our argument plain. Making this hypothetical supposition that a dot in the negative is



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HALF TONE NEGATIVES

Fig. 80. Enlarged Portion of Half Tone Negative.—Fig. 81. Typical Half Tone Negative.

one inch wide, and that we etch it one-half inch deep, and that the iron chewed into it on each side one-half of an inch, it will be seen that there will be no dot left at all, and if there were a series of such dots of that size and all were chewed in this same ratio, there would be a white spot left in the cut, and the paper would certainly bottom and make a nasty, smudgy mark when it was printed. As it is absolutely necessary that the plate should be etched to printing depth, and as it is also necessary that the dots should be there after etching, the only thing to do is to make the dots in the negative large enough to stand the plate being etched to the required depth, leaving them still there when through. For this reason all high light dots are made much heavier in the negative than they are expected to be in the finished plate, in consequence of which there does not appear so much contrast in the negative as will show in the finished cut. This completes the three great requirements of a half-tone negative, and these are:

First. That the negative reproduces the copy accurately.

Second. That it is clear glass and opaque film, so that it will print properly on the copper.

Third. That there is enough latitude in the size of the dots so that the etcher can obtain good printing depth in the finished plate, and still have dots where they should be.

The successful filling of these requirements (always assuming that the bath is in good condition and all chemicals correct), depends upon correct exposure, development, intensification, and cutting. Experience, here as everywhere, is a great factor; practice must be combined with theory, and doing must be added to knowing, for manipulation counts for much, and expertness in handling is a matter of great importance.

A typical half tone negative is shown in Fig. 81.

Half Tone Stripping and Printing

The method of flowing a half tone negative with rubber and collodion and also the making up of a flat is the same for half tone as it is for line, but the trimming of the negative for certain work differs in some respects. There are three regular finishes for half tone engravings, viz., square finish, cut out, and vignette, shown in Fig. 82, Fig. 83, and Fig. 84. The square finish is the natural one for half tone work, and is the most popular for many reasons. Cut out and vignette negatives are treated by the stripper in the same manner as line work by cutting through the negative with a sharp knife, at a sufficient distance away from the work to leave a margin, but a square finish negative is laid upon the cutting table and trimmed up along a straight edge to the exact size the cut is to be, as in Fig. 85. In making up a flat, one-half inch is generally left between negatives, so that there will be ample room for saw and beveling cuts.

Much the same process is gone through in preparing the copper for printing as was the case with zinc, all grease is removed, etc., and, in flowing the plate, follow the procedure outlined for zinc, allowing the first flowing of the plate to drain into the sink, then flow again and drain into the bottle. The reason for this is that no water will mix with the solution, and thin it out or make it uneven. The thinner the solution is on the plate, and the less there is of it, the faster it prints, as it takes the light much longer to penetrate a heavy or thick film; and as there may be a flat tone in the copy, such as a sky, or the side of a face, if one part was strongly printed and the other washed away in developing, it will be readily seen that the result would be disastrous to the cut, because unevenness of tone would result. The solution must go on absolutely smooth, even, and of the same density all over the plate. It is almost impossible to do this properly by hand, so the plate is clamped into a machine called a whirler, Fig. 31, which spreads the solution absolutely even. Care must be taken of the speed with which the plate is whirled, for if it be too fast it will spin a lot of the solution off and make it very thin and consequently a bad resist for the etching. Like the zinc solution, it must be dried by gentle heat, and the utmost care must be taken that it does not become too hot, or the solution will "set" and not print. A good way to test it is to touch the back of the plate with the back of the hand, to which it should feel good

and warm, but not scorching. When the plate is whirled set away in a dark corner to cool, and it is then ready for the frame.

Exposure and Developing. The exposure depends largely upon the screen, and the light used, though it is fairly constant when once a time has been established. The printer should always mix his solution the same, keep the lights at a certain distance, and, in fact, do all possible to have conditions for each print approximately the same, then the exposure time can be made constant. If this is done, printing is comparatively easy, otherwise the printer is apt to be in continual trouble. The average time is probably around ten minutes, and the plate is then removed from the frame and placed in a tray of water, which should dissolve the parts away upon which the light has not acted. As a matter of fact, it seldom does, and in cold weather a little warm water is a great help in developing the print; then, if this does not "open" it up, that is, clear up the detail so that the print is a duplicate of the negative, water is squirted upon it by a rose nozzle placed on the water faucet. This will shoot a fine stream with much force over the surface of the print, loosening the solution, detaching it from the surface of the print, and washing it away.

As it is rather difficult to judge whether all detail is up or not on the average print, the film is often stained with some color, usually aniline in character, and gen-

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FINISHES OF HALF TONE ENGRAVINGS

Fig. 82. Square Finish.—Fig. 83. Cut Out.—Fig. 84. Vignette.

erally either eosine or methyl violet. This enables the printer to see whether all of the detail, particularly in the dark parts of the picture, is printed up. It is very necessary that the high light dots should be strong and solid, and that the white dots in the shadows are fully developed out and free from "scum." What is not on the print will not be in the etching.

Burning In. When developed, the print is burnt in, by being laid, back down, on a gas stove, and kept moving until the sensitizing solution has turned to an enamel. The usual color is a rich golden brown, and it is this enamel that forms the resist in a copper print. After "burning in" the plate is laid away to cool before being etched. Burning in should never be hurried, a large plate taking as long as eight or ten minutes, during which time it lies on top of the gas flame, being continually moved around by the pliers. The object of keeping the plate moving is to have the heat even over the whole of the plate. The plate should be left until the enamel turns a rich chocolate brown, after which it should be put on one side and allowed to cool. When quite cold it is ready for the etcher.

Because of the difficulty of seeing positively if all of the detail of a print is "up," many printers keep a solution of chromic acid handy, and flow it over the developed print. The acid causes the exposed copper to shine and sparkle and the presence of scum is readily detected. If all of the detail does not make its appearance in the

shadows, then the print is no good—it must be polished off of the copper and a new one made.

Half Tone Etching on Copper

The first thing the half-tone etcher does, after taking up a new flat, is to look it over very carefully with a glass, and spot up any place where the dots are missing, or anything else wrong with the print. This is usually done with a fine brush and asphaltum. Care must be exercised that the spotting is done with great pains, as carelessness means so much more work for the finisher, and, maybe, the obscuring of very necessary detail. When he is satisfied that all weak places are covered, and the back of the plate is painted with asphaltum, he is ready to give it a "flat" etch.

Method of Etching. The question of half-tone etching has caused some controversy, as there are two ways of doing it, viz., face up and face down. Each side has its good points, each one its bad features, and the etcher must decide for himself which one suits him best. Those who etch face up claim that the work is in evidence all the time, that they can see what they are doing at any moment and that it is the natural way to work; those who etch face down claim that the first bite must go to printing depth in any case, and that it is not necessary to see, and that it is a matter of a certain time, and that the copper that is etched away by the acid falls down to the bottom of the bath away from the plate,

instead of settling into the crevices of the half tone and delaying the action of the etching. It is simply a case of individual preference; good work is done by both methods, and each man can choose for himself.

In either case the etcher takes the plate in his hand, and brushes the iron over the face of it, so that no air will stay in the small holes of the enamel, then puts it into slits in a pair of wooden holders, Fig. 89 and Fig. 90. These are simply two pieces of wood, into which two grooves have been cut, A and B, for the reception of the edges of the plate. The short edges of a large plate are placed in them—for a small plate it does not matter which edge is used—and their particular use is to make it convenient to remove the plate from the bath. They must be wide enough to stand steadily. Slide the plate beneath the iron, moving it about for a moment or two, so that the iron will have free access to every part of it, and then let it lie quiet, resting upon the two slots in the wood.

The length of time that must be given for a first bite varies somewhat with the character of the work, the strength of the iron, and the fineness of the screen. An ordinary job, one-thirty-three-line screen, will probably take a four- or five-minute etch, but, in any event, it should go down to a proper printing depth. As good a test as any is that given in zinc etching, viz., scratch a place in the solid enamel along the edge and feel with the thumb nail. Take the plate out of the iron, brush

a corner lightly with the etching brush to remove any deposit, and test for depth. If it seems deep enough, examine with the glass, and then, if satisfied, wash off the iron, daub it dry with the chamois, and heat a trifle over the gas to remove any moisture. If not deep enough, do not wash off, but put back into the acid for further etching. It is bad policy to be continually taking a plate out of the bath to test it, for too much brushing, or too much water have a bad effect on the enamel, and may cause it to crack and leave the plate.

When satisfied that the etching is deep enough the plate is ready for staging, which is the etching of color, or contrast, into it.

Staging. In Fig. 86 is shown a cut which has had a flat etching, and it will be noticed that while the shadow parts of the picture are brought out in good shape, the lighter portions are too dark, and the cut looks unfinished and heavy. Staging answers two purposes, the first of which is to give life and contrast to the cut; the second, the securing of proper printing depth to the lighter tones of the picture. In the darker portions the white places are small, the dark places (which carry the ink and bear the weight of the paper) are large, so the depth can be small; in the light tone places the dark spots are small, and the white places large, and this naturally requires greater depth for proper printing. Staging covers both of these needs. As stated in the

portion of this book on photography, the high light dots of the negative are always made larger than they will show in the finished cut, to allow of a satisfactory depth being attained, and also to give the etcher some latitude in the work.

After the iron is washed off and the plate dried, it is dusted all over with powdered magnesia, face powder, or a piece of the lump magnesia is rubbed over the surface of the plate. This catches in all the parts that have been etched, the surfaces of the plate showing up dark against it. The surplus powder is usually removed with the flat of the hand. The cut shows now just as it would if printed, and the etcher studies it carefully, compares it with his copy, and decides which portions are etched enough, and which require to be lightened. Those that are light enough are painted in with asphaltum, and the plate is given another bite, and if necessary, the operation is repeated. It is not necessary to remove the magnesia out of the cut, as it will dissolve away in the iron. Most plates require a couple of stages. Some etchers prefer etching ink to asphaltum, dusting the surface with dragon's blood, which, for this purpose, does not require melting. Where the stage is to be blended, or where any edge of the staging must not show in the finished cut, the brush is used very dry and the part is not painted solid, but graduated down to white.

How the Iron Works. Staging etches are generally short, the copper being left in the acid for only a minute

or two, according to the distance the copper must etch down to lessen the size of the dots, etc., to the right size. An explanation of the manner in which the iron works will make both the method and the result plain. In Fig. 91 is shown an enlarged section of a copper plate with only the enamel print upon the top of the plate (where the enamel shows would be the part of the plate to print black on the paper). In Fig. 92 is another view of the same section after it has had a flat etch, and it will be seen that the iron has cut into the copper sideways beneath the enamel, as well as downward. In Fig. 93 is shown the same section after staging, and it will be seen that the etching is very much deeper and the dots much more undercut beneath the enamel. This enamel has little strength of itself, and soon breaks off where it overhangs the dots, giving the effect shown in Fig. 94. The bottom of the etch is very much deeper than it was when shown in Fig. 92, and the dots are thinner, and this is the theory of reëtching, greater printing depth as well as more color in the cut, because a smaller black dot necessarily makes a lighter tone. One of the arguments against etching face upward has to do with this result, the statement being that the dissolved copper falls to the bottom of the place etched and impede the action of the iron in this direction, making it expend its force sideways. Fig. 87 is the same cut as Fig. 86, but with one staging upon it, and its improvement is easily seen.

Reëtching. Few cuts are considered finished, even

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HALF TONE ETCHING

Fig. 85. Square Finish Half Tone Negative.—Fig. 86. Flat Etch of Fig. 85.

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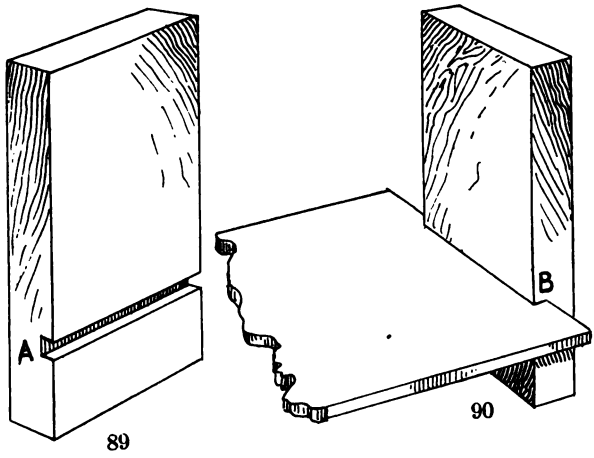
STAGING, ETC.

Fig. 87. Etching of Fig. 85 Staged.—Fig. 88. Reëtching.



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SECTIONS, ETC.

Fig. 89.—Wooden Plate Holder.—Fig. 90. Wooden Plate Holder with Plate.—Fig. 91. Section of Half-tone Print.—Fig. 92. Section of Half-tone Print, flat etched.—Fig. 93. Section of Staged Print.—Fig. 94. Section of Reëtched Print.

when the last stage is given, for there may be some small places that need lightening up still more, or spots where a high light is needed, but where no sharp edge must show, and this work is usually done by reëtching. The plate is cleaned of all ink, asphaltum or other substance and filled with magnesia as usual, the reëtching then being done by dipping a brush in iron, and scrubbing the place to be lightened, after which the iron is wiped off by a pledget of cotton wet with water or alcohol. The brush is generally used with the right hand, the cotton with the left, and the iron given only a moment or two for cutting, being immediately washed off, as most etchers prefer to reëtch again rather than take the chance of etching too much. One place may be gone over a dozen times or more. When the plate looks as though all the reëtching had been done, a flat proof is pulled to make sure, and if it shows completely finished, it is turned over to be beveled or whatever is required; if not, it is given further treatment. As iron attacks tin ferrules and most other metals, the reëtching is generally done with a Japanese brush, in which the hair is set into bamboo.

When finished, the plate is brightened up with the solution of salt.

Fig. 88 shows Fig. 86 and Fig. 87 reëtched, as well as staged. Note particularly the water in the rocky portion.

Combination Line and Half Tone

Occasionally an engraving is demanded that must be part line and part half-tone, as, for instance, a customer desires a photograph reproduced in a line background, one in which there may be black and white lettering, or possibly, decorative pen and ink work. Sometimes the cuts can be made separately and blocked together, or the half tone may be mortised into the line cut, but sometimes this cannot be done, or, for other reasons, it is desirable to make one homogeneous etching of the two. This is done by stripping the two negatives into each other, that is, making the combination of the line and half-tone at the time the negatives are stripped instead of at the time of blocking, or by mortising. The photographer, of course, makes two negatives, one half-tone, and one line, and the combination is made. By handling the work in this way, the cut is made upon one piece of metal and is a solid, homogeneous whole, without patching or weak places. Such work requires care and delicate handling, and is usually done by laying one of the negatives over the other, and then cutting through both at the point where they are to join. Fig. 95, for instance, is the job to be stripped together, and the zinc negative is laid down upon the stripping glass with plenty of water over it, and then the half-tone negative is laid on top and moved around until it is on the exact spot where it is to show in the finished engraving. When

Fig. 95. Combination Line and Half Tone.

Fig. 96. High Light Half Tone.

they are accurately registered upon each other, a little of the water is squeezed from below them, so they will not slide about, and the point of jointure is cut through with a very sharp knife. The part of the half-tone negative is removed from that part of the line one which is to be printed, and then the part of the line one below where the half-tone is to print is taken away, or vice versa, according to which is on top. The print is made with enamel in the ordinary manner, and the flat bite given in the iron, as for regular half-tone work, and whatever staging or reëtching may be necessary is done then. After this is finished, the half tone is stopped out or painted over with asphaltum and the plate is then treated as a line zinc cut, being powdered up and etched in the same manner, excepting that it is etched in iron instead of acid, though the tub containing the solution is rocked, in contradistinction to ordinary half-tone etching, in which the solution is stationary. A moving solution etches much quicker than a stationary one, and it would take an interminable time to etch down a line cut on copper in a stationary mordant. When deep enough it is routed and blocked as usual.

High Light Half Tone

If, in the average half-tone cut, there is to be a solid white, it is generally tooled out by the finisher, which is the quickest and cheapest thing to do; but for some

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